# FUEL CELL DEVICE

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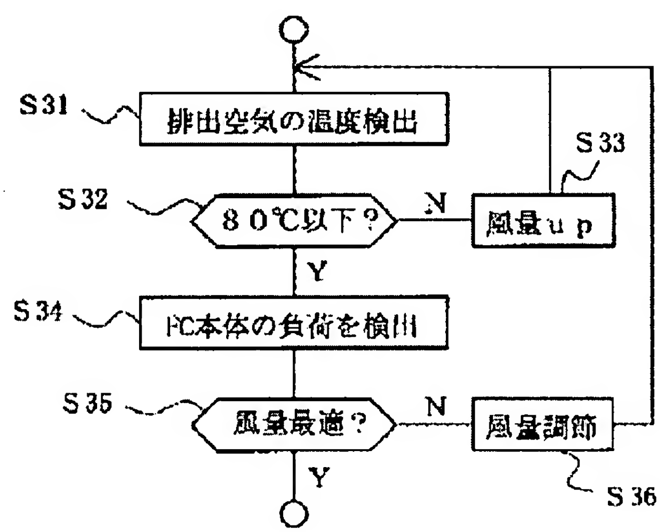
Abstract of **JP2001332278**

PROBLEM TO BE SOLVED: To solve the problem in the conventional cell devices that an electrolyte for the so-called PEM type fuel cell, having a membrane of a polymer solid electrolyte requires a water because of transmitting protons, when the temperature of the fuel cell increases, the water in the electrolyte is liberated, an electrolyte resistance is increased, and an operation is to be suspended, and the fuel cell device in which these problems are solved and which is operated efficiently has a simple structure, and to provide an operating method (a controlling method) therewith. SOLUTION: To check the operation of the fuel cell main body, to control, under an on and off condition, a water supply to an air electrode supplied depending on a checked operation, as well as to regulate, under an on condition, wind to the air electrode through increasing or decreasing the volume of the wind. For example, when the exhaustion gas temperature of the fuel cell main body is low, the water supply through the water supply means is suspended, while the exhaustion gas temperature is high, a liquid supply is provided through the water supply means. When the exhaustion gas temperature is low, the volume of the wind is decreased through the wind volume regulating device, while when the exhaustion gas temperature is high, the volume of the wind is increased through the wind volume regulating device.



JAPANESE [JP,2001-332278,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART TECHNICAL PROBLEM MEANS EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

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* NOTICES *



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## CLAIMS

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[Claim(s)]
[Claim 1] The body of a fuel cell equipped with the fuel electrode and air pole which were arranged so that an electrolyte and this electrolyte might be pinched, A liquid supply means to supply a liquid to said air pole front face, and the blast weight adjustment which adjusts the blast weight which ventilates said air pole front face, While supplying the liquid by said liquid supply means by on-off control according to an operation situation detection means to detect the operation situation of said body of a fuel cell, and the detected operation situation Fuel cell equipment characterized by having the control unit which adjusts airflow by said blast weight adjustment by the change in airflow by the ON state.
[Claim 2] The operation situation which said air pole is equipped with the inlet port and outlet of ventilation, and said operation situation detection means detects is fuel cell equipment according to claim 1 characterized by being the exhaust-gas temperature of said outlet.
[Claim 3] Said control unit is fuel cell equipment according to claim 2 characterized by what the liquid by said liquid supply means is supplied for when an exhaust-gas temperature is high while suspending supply of the liquid by said liquid supply means, when an exhaust-gas temperature is low.
[Claim 4] Said control unit is fuel cell equipment according to claim 2 or 3 characterized by what blast weight by said blast weight adjustment is enlarged for when an exhaust-gas temperature is high while making small blast weight by said blast weight adjustment, when an exhaust-gas temperature is low.
[Claim 5] Said operation situation detection means is fuel cell equipment according to claim 1 which detects the operating temperature of said body of a fuel cell, and is characterized by what said control unit is controlled for so that said operating temperature becomes within the limits of predetermined.
[Claim 6] It is fuel cell equipment according to claim 5 characterized by what supply of the liquid by said liquid supply means is suspended for when the operating temperature of said body of a fuel cell is low.
[Claim 7] While supplying said liquid supply means **** liquid regardless of an operating temperature in the case of starting of said body of a fuel cell, after termination of starting is fuel cell equipment according to claim 5 or 6 characterized by what the liquid by said liquid supply means is supplied for corresponding to an operating temperature.

[Claim 8] The body of a fuel cell equipped with the fuel electrode and air pole which were arranged so that an electrolyte and this electrolyte might be pinched, A liquid supply means to supply a liquid to said air pole front face, and the blast weight adjustment which adjusts the blast weight which ventilates said air pole front face, An operating-temperature detection means to detect the operating temperature of said body of a fuel cell, and the liquid supply control unit which controls said liquid supply means to supply a liquid when an operating temperature is beyond a predetermined value, and to suspend supply of a liquid to the case of under said predetermined value, Fuel cell equipment characterized by having the blast weight control unit which controls accommodation of the airflow by said blast weight adjustment corresponding to an operating temperature.
[Claim 9] Said liquid feeder is fuel cell equipment according to claim 8 characterized by supplying a liquid intermittently when an operating temperature is below a predetermined value.
[Claim 10] For said liquid supply control unit, after termination of starting is fuel cell equipment according to claim 8 characterized by what the liquid by said liquid supply means is supplied for corresponding to an operating temperature while supplying the liquid by said liquid supply means regardless of an operating temperature in the case of starting of said body of a fuel cell.
[Claim 11] While supplying a liquid to said air pole front face to the body of a fuel cell equipped with the fuel electrode and air pole which were arranged so that an electrolyte and this electrolyte might be pinched While being the approach of controlling the fuel cell equipment of a configuration of ventilating said air pole front face in air, detecting the operation situation of said body of a fuel cell and supplying said liquid by on-off control according to the detected operation situation The control approach of the fuel cell equipment characterized by adjusting airflow by the change in airflow by the ON state.
[Claim 12] The control approach according to claim 11 characterized by what said operation situation is detected for based on the exhaust-gas temperature of said air pole outlet.
[Claim 13] The control approach according to claim 12 characterized by what said liquid is supplied for when an exhaust-gas temperature is high while suspending supply of said liquid, when an exhaust-gas temperature is low.
[Claim 14] The control approach according to claim 12 or 13 characterized by what blast weight is enlarged for when an exhaust-gas temperature is high while making blast weight small, when an exhaust-gas temperature is low.
[Claim 15] The control approach according to claim 11 characterized by what said operation situation is detected for based on the operating temperature of said body of a fuel cell.
[Claim 16] It is the control approach according to claim 15 characterized by what supply of a liquid is suspended for when the operating temperature of said body of a fuel cell is low.
[Claim 17] After termination of starting is the control approach according to claim 15 or 16 characterized by what said liquid is supplied for corresponding to an operating temperature while supplying said liquid regardless of an operating temperature in the case of starting of said body of a fuel cell.

[Claim 18] While supplying a liquid to said air pole front face to the body of a fuel cell equipped with the fuel electrode and air pole which were arranged so that an electrolyte and this electrolyte might be pinched It is the approach of controlling the fuel cell equipment of a configuration of ventilating said air pole front face in air. The control approach of the fuel cell equipment characterized by what the operating temperature of said body of a fuel cell is detected, a liquid is supplied when said detected operating temperature is beyond a predetermined value, supply of a liquid is suspended to the case of under said predetermined value, and blast weight is adjusted for corresponding to said detected operating temperature.
[Claim 19] The control approach according to claim 18 characterized by supplying a liquid intermittently when said detected operating temperature is below a predetermined value.
[Claim 20] It is the control approach according to claim 18 characterized by what after termination of starting supplies a liquid for corresponding to said detected operating temperature while supplying said liquid regardless of said detected operating temperature in the case of starting of said body of a fuel cell.
[Claim 21] Said liquid is fuel cell equipment according to claim 1 to 10 characterized by what is been water.
[Claim 22] Said liquid is the control approach according to claim 11 to 20 characterized by what is been water.

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to moisture maintenance of the electrolyte layer pinched between an oxygen pole and a fuel electrode in detail about fuel cell equipment. It is suitable for the so-called PEM type which has especially the solid polymer electrolyte film of fuel cell equipment.
[0002]
[Description of the Prior Art] The cell proper of fuel cell equipment is a fuel electrode (it is also called a hydrogen pole when using hydrogen as a fuel electrode), and an air pole (since oxygen is reactant gas, it is also called an oxygen pole.). Moreover, while also calling it an oxidation pole, it is the configuration that the electrolyte was pinched.
[0003] Since a proton is made to conduct, if the temperature of a fuel cell becomes [ the place which needs to contain moisture ] an elevated temperature, the moisture in an electrolyte is emitted, and electrolytic resistance will become large and it will become impossible by the way, to operate the above-mentioned electrolyte.
[0004]
[Problem(s) to be Solved by the Invention] This invention offers the fuel cell equipment which can be efficiently operated with a simple configuration, and its operating method (the control approach).
[0005]
[Means for Solving the Problem] This invention is made in view of the above-mentioned technical problem, and that configuration is as follows. Namely, the body of a fuel cell equipped with the fuel electrode and air pole which were arranged so that an electrolyte and this electrolyte might be pinched, A liquid supply means to supply a liquid to said air pole front face, and the blast weight adjustment which adjusts the blast weight which ventilates said air pole front face, While supplying the liquid by said liquid supply means by on-off control according to an operation situation detection means to detect the operation situation of said body of a fuel cell, and the detected operation situation Fuel cell equipment characterized by having the control unit which adjusts airflow by said blast weight adjustment by the change in airflow by the ON state.
[0006] Thus, according to the constituted fuel cell equipment, since the amount of

supply of process air serves as adjustable, cooling using the latent heat of the water supplied to the air pole is performed fully and efficiently by changing the amount of supply of process air and making this into the optimal amount. By this, ******, as a result the body of a fuel cell will be cooled efficiently. In addition, it considers as a means to use the latent heat of water efficiently, and, as for the particle size of water, it is desirable to be referred to as 50 micrometers - 500 micrometers. As for the thickness of the electrolyte membrane of the body of a fuel cell, it is desirable that it is 200 micrometers or less. That is, the temperature of the body of a fuel cell is operated at an elevated temperature, and the amount of supply (blast weight, the air content supplied to per unit time amount, air content which passes an air chamber A (refer to drawing 3 ) to per unit time amount) of air is enlarged in the bottom to which the water of an amount is supplied enough to lower the temperature of this. By the type of immobilization of the amount of air supply, in order to use the sensible heat of water, there was fault of the need [ of supplying a lot of water ] top versatility, but even if it makes [ many ] the amount of air supply, fault is hardly produced. the load applied to air supply equipments (fan etc.) even if it makes [ many ] the amount of air supply -- amount of water -- it is because it is so small that it can ignore compared with the load which is applied in increase. The body of a fuel cell is operated at low temperature, and airflow is dropped to raise the temperature of this so that the amount of air supply may not become superfluous. Thereby, while being able to raise the temperature of the body of a fuel cell certainly, power consumed with air supply equipment is made small as much as possible, it has it, and reduction of power loss is aimed at. Moreover, since internal temperature goes up and a temperature gradient with the open air becomes large also about the condenser for water recycle, the capacity can be made small. Furthermore, according to this invention, according to operation situations, such as an operating temperature of the body of a fuel cell, on-off control of the supply of the water which is a liquid is carried out. the overage of water can be prevented by preparing off time amount in supply of water -- both the power consumption of a liquid feeder can be reduced as much as possible. Since it is controlled by turning on and off, even if it injects a lot of water at the time of ON, the average coefficient of water absorption per unit time amount is uniformly controllable by adjusting the time amount of OFF. Water can be supplied uniformly and certainly to the whole surface of an air pole by making a lot of water inject at the time of ON. Thus, it becomes possible by controlling the blast weight of air, and/or the amount of supply of a liquid to store the operation situation (operating temperature) of the body of a fuel cell within the limits of predetermined. Instead water can be alike, or it can use together with water, and liquids, such as alcohol, can be used.

[0007] According to this invention, since the amount of supply of air and the amount of supply of water have been independent, compared with the supply system which they have not been independent of, the required amount of supply is [ each of air and water ] controllable [ independently ] by required timing. There is no futility and the output of a high fuel cell is efficiently obtained by that. Moreover, since the amount of the air and water to collect can also be made into the minimum, a condenser can also be made small and also becomes saving of the

power consumption by the accessory vessel. Moreover, the time amount concerning starting can also be shortened.

[0008] Drawing 1 shows the relation on the theory of the load (current density) of the body of a fuel cell and temperature (air exhaust-gas temperature) in each SUTOIKI ratio. The air content supplied here at an air pole on the basis of the process air content which contains the amount of oxygen on the theory consumed at a fuel cell reaction with a SUTOIKI ratio is specified. Therefore, when a SUTOIKI ratio is 1, it is the case where the minimum required air content is sent theoretically, and if a SUTOIKI ratio is set to 2, the amount of air supply will become the twice at the time of the SUTOIKI ratio 1. It turns out that the body of a fuel cell can be operated at high temperature although such same load that there are so few amounts of air supply that a SUTOIKI ratio is small than drawing 1 is obtained. Effectiveness becomes higher as the operating temperature of the body of a fuel cell has this high. Moreover, since the temperature of discharge air also goes up by the elevated-temperature operation, capacity of a condenser can also be made small. Therefore, it is desirable to operate the body of a fuel cell at the highest temperature that can provide the load demanded. Since the temperature of a load and the body of a fuel cell is uniquely decided on by the SUTOIKI ratio, what is necessary will be to detect one side of a load and temperature and just to decide the SUTOIKI ratio of air supply, i.e., the amount, (amount strictly supplied to an air chamber inlet port).

[0009] However, in the present fuel cell, the operating temperature and SUTOIKI ratio (the amount of air supply) of the body of a fuel cell have various kinds of limits. For example, in order to prevent printing of the body of a fuel cell certainly, it is necessary to make the operating temperature into 100-80 degrees C or less. Moreover, according to examination of this invention persons, operation on the conditions above the broken line L shown in drawing 1 was impossible. This is presumed to be what is depended on the reason of air not reaching an air pole enough for resistance of an air supply way or a gaseous diffusion layer, the capacity of a catalyst, etc., when there are few amounts of air supply (when airflow is small). Therefore, in drawing 1 , it is 80 degrees C or less, and the body of a fuel cell can be operated in the field below a broken line L (predetermined within the limits). And if the effectiveness is taken into consideration, it is desirable to operate this on the maximum-temperature edge of the field concerned which can be operated.

[0010] With the fuel cell equipment for vehicles with an intense load effect, the amount of air supply is changed according to the load demanded. It is desirable to adjust the amount of air supply so that it may become the maximum temperature which detects the temperature of the body of a fuel cell to coincidence then, and can realize the demanded load, i.e., the minimum SUTOIKI ratio, (the amount of air supply). What is necessary is to supervise only the temperature of the body of a fuel cell substantially, and to adjust the amount of air supply in the fuel cell equipment used in the environment where a load is hardly changed, on the other hand, so that this may serve as desired temperature only when the temperature is changed. That is, when the temperature of the body of a fuel cell becomes lower than a desired temperature requirement, the cooling effect which was made to

reduce the amount of air supply and used the latent heat of water is lowered, and when the temperature of the body of an another side fuel cell becomes higher than a desired temperature requirement, the cooling effect which increased the amount of air supply and used the latent heat of water is raised. Various limits are imposed on the service condition of fuel cell equipment with an external environment or the engine performance of auxiliary machinery. It may be restricted to the field square [ of the body of a fuel cell / in the condition field in drawing 1 which can be operated ] and shown depending on the case. In this field, the operating temperature of the body of a fuel cell does not exceed Rhine of the SUTOIKI ratio 1 (in order to always work the body of a fuel cell, the air content corresponding to the SUTOIKI ratio 1 shall always be supplied at least). Therefore, it is not necessary to supervise the temperature of the body of a fuel cell. Therefore, only a load is supervised and the air of the minimum amount in which an output is possible is supplied in the load concerned.
[0011] the above -- in the case of which, the water of always sufficient amount for an air pole shall be supplied That is, even if there are some which evaporate with the heat of the body of a fuel cell, liquid-like water shall always exist in an air pole and its perimeter (namely, inside of an air chamber) during operation of fuel cell equipment. Thus, since water always exists in an air pole, as a result of being able to use the latent heat of water efficiently, a cooling plate can be thinned out from the stack of the body of a fuel cell, or this can be omitted. It is desirable to equip the stack of the body of a fuel cell with the cooling system of a cooling plate or a cooling pipe, and others in consideration of the case where there is a possibility that evaporation of sufficient quantity of water may not be securable. The heat of a stack can be taken out outside with the heat carrier (usually water) which circulates to this cooling system, and it can use for heating in the car etc. (use as the so-called KOJIENE).
[0012] In the above, process air is supplied to an air pole, without being compressed substantially. In addition, this invention is also applicable to the fuel cell equipment of a type equipped with the pressurized oxidation gas supply system. When an oxidation gas supply system is equipped with the compressor of oxidation gas, also when the inside of a system serves as a pressure higher than atmospheric pressure by duct resistance of gas piping, it is contained in the pressurized oxidation gas supply system concerned from the first. Although the temperature of the body of a fuel cell attaches a thermometer to the body of a fuel cell concerned and this can be measured of course, as shown in drawing 1 , it is also possible by measuring the temperature of exhaust air air to measure the temperature indirectly. In this case, it is desirable to measure the temperature of the air immediately after discharging from the body of a fuel cell. Based on such temperature, the operation situation of the body of a fuel cell is detected. A thermometer serves as an operation situation detection means. The loads of the body of a fuel cell are a current between the two poles of the body of a fuel cell, and the product of an electrical potential difference. As a parameter considered as reference when controlling the amount of supply of process air, the present load which the body of a fuel cell is outputting actually can be detected, and this can be used. In addition, the opening of the load required of the body of a fuel cell at a

degree, for example, a rate, torque, or an accelerator can be detected, and this can also be used as the parameter concerned.

[0013]

[Example] Next, the example of this invention is explained. Drawing 2 shows the outline configuration of the fuel cell equipment 1 of an example. Drawing 3 shows the basic unit of the body 10 of a fuel cell. As shown in drawing 2 , the outline configuration of this equipment 1 is carried out from the body 10 of a fuel cell, the hydrogen gas supply system 20 as fuel gas, the air supply system 30, and the water supply system 40.

[0014] The unit unit of the body 10 of a fuel cell is the configuration which pinched the solid-state polyelectrolyte film 12 with the air pole 11 and the fuel electrode 13. With actual equipment, two or more sheet laminating of this unit unit is carried out (fuel cell stack). The air manifolds 14 and 15 for inhaling and exhausting air, respectively are formed in the upper part of an air pole 11, and a lower part. The mounting hole for attaching a nozzle 41 is formed in the upper manifold 14. In order for the jet include angle of the water which blows off from a nozzle 41 to have a limit, and to make water into the shape of a fog and to spread this all over an air pole 11, predetermined spacing is needed between a nozzle and an air pole 11. Therefore, this manifold 14 becomes what has the comparatively high back. On the other hand, the lower air manifold 15 shall discharge the dropped water efficiently. In addition, a nozzle can also be prepared in the side face of a manifold 14. The water which blows off from this nozzle will spread the whole region in a manifold 14, and, therefore, will spread all over an air pole 11. By preparing a nozzle in the side face of a manifold 14, a low manifold is employable. Therefore, the miniaturization of the body of a fuel cell can be attained.

[0015] As for a nozzle, it is desirable to inject direct water towards an air pole front face. Thereby, the water of a desired amount can be supplied to an air pole front face regardless of the amount of air supply. That is, it becomes controllable independently about the amount of supply of air, and the amount of supply of water (independent supply type). According to this independent supply type, also in the condition of the big amounts of air supply (airflow), such as the time of starting, the water of the amount of requests can be certainly supplied to an air pole front face. Therefore, compaction of warm-up time can be aimed at. Waterdrop is emitted into airstream and the amount of air supply and the water amount of supply cannot be controlled independently by the type which puts this on airstream and is supplied to an air pole (un-independent supply type). Modification of the amount of air supply and modification of the water amount of supply are not always required of coincidence, and those modification may be needed independently. For example, when only the amount of supply of air needs to be changed and even the amount of supply of water is changed, there is a possibility of the response of control of the body of a fuel cell becoming late, as a result causing the loss of power of fuel cell equipment. On the other hand, since the water and/or air of a complement can be supplied to required timing, the body of a fuel cell is efficiently controllable by the independent supply type which this invention adopts. Moreover, supply of useless air and useless water is avoided by controlling supply of water and air independently. It also sets at this point and is ** with efficient operation of

the body of a fuel cell. Furthermore, capacity of a condenser can also be made small by avoiding supply of useless water or useless air.
[0016] As shown in drawing 3 , the unit unit of the above-mentioned air pole 11-solid-state polyelectrolyte film 12-fuel electrode 13 has the shape of thin film, and is pinched with the connector plates 16 and 17 made from carbon of a pair. The slot 18 for circulating air is formed in the field of the connector plate 16 which counters an air pole 11 two or more articles. Each slot 18 is formed in the vertical direction, and is opening manifolds 14 and 15 for free passage. Consequently, the water of the shape of a fog supplied from a nozzle 41 reaches to the lower part of an air pole 11 along the slot 18 concerned. An air chamber A is constituted by the peripheral surface of this slot 18, and the expressional side of an air pole 11. Illustration top opening of an air chamber A is the inlet port (upstream opening) of ventilation, and opening of the illustration bottom is the outlet (downstream opening) of ventilation. It is desirable to form a thermometer so that the exhaust-gas temperature of this outlet may be detected. Although it is the configuration which liquids, such as water, are made to blow off directly to upstream opening, and supplies them in the example, liquids, such as water, can also be supplied from downstream opening. Furthermore, the through tube of an illustration longitudinal direction can be formed in a connector plate, and liquids, such as water, can also be supplied to an air chamber A from here. Thus, the supplied water evaporates chiefly in the field (the peripheral surface of a slot 18, and the expressional side of an air pole 11: these tend [ comparatively ] to become an elevated temperature) which constitutes an air chamber A. Similarly, the slot 19 for circulating hydrogen gas is formed in the field of the connector plate 17 which counters a fuel electrode 13. In the example, two or more articles of this slot 19 were formed horizontally. A combustion chamber B is formed in respect of expression of the peripheral surface of this slot 19, and the connector plate 17. Water can also be supplied to this combustion chamber B by the same approach as the air chamber A as stated above.
[0017] Since water is supplied to an air pole 11, this is formed with an ingredient with a water resisting property. Moreover, since the effective area of an air pole 11 will decrease if the film of water is made there, high water repellence is also required of the ingredient of an air pole 11. The carbon cross was applied as this ingredient, (C+PTFE) was applied as a base material, and the crowded gaseous diffusion layer was used. The thin film of general-purpose Nafion (trade name: Du Pont) was used for the solid-state polyelectrolyte film 12. In addition, if the reverse osmosis of the generation water from an air pole side is possible for membranous thickness, it will be good, for example, will be set to 20-200 micrometers. The fuel electrode 13 is formed with the same structure as an air pole 11. Structure may be changed by the fuel electrode 13 and the air pole 11.
[0018] Homogeneity distributes, respectively and the well-known platinum system catalyst used in order to promote the reaction of oxygen and hydrogen as it is also at a certain amount of thickness is formed in the field of the direction which contacts an electrolyte membrane 12 in an air pole 11 and a fuel electrode 13 as a catalyst bed in an air pole 11 and a fuel electrode 13.
[0019] As a hydrogen feeder 21 of the hydrogen gas supply system 20, the

hydrogen bomb which consists of a hydrogen storing metal alloy was used in this example. in addition, the reforming reaction of the reforming raw materials, such as a hydrogen bomb of liquid hydrogen, and water / methanol mixed liquor, is carried out with a reforming vessel -- making -- hydrogen -- rich reformed gas is made to generate, this reformed gas is stored in the tank, and this can also be made into the source of hydrogen. Hydrogen piping can be made into the source of hydrogen when using fuel cell equipment 1, fixing indoors. The hydrogen feeder 21 and the fuel electrode 13 are connected by the hydrogen gas supply way 22 through the hydrogen supply pressure regulating valve 23. A pressure regulating valve 23 adjusts the flow rate of the hydrogen gas supplied to a fuel electrode 13, and can use the thing of a general-purpose configuration.
[0020] The exhaust gas from a fuel electrode 13 is discharged to the open air. In addition, this exhaust gas can be supplied to an air manifold, and it can also mix with air here.
[0021] Air is supplied to an air pole 11 by the fan 38 from the inside of atmospheric air. The sign 31 of drawing is the supply way of air, and is connected with the manifold 14 of an air pole 11. The air conduit 32 for circulating through or exhausting the air which passed the air pole 11 is connected with the lower manifold 15, and exhaust gas is sent to the exhaust air way 36 through the condenser 33 which separates water. The amount exhausted by the opening of the air exhaust air pressure regulating valve 34 from the exhaust air way 36 is adjusted. Moreover, the exhaust air pressure regulating valve 34 can be omitted, and it can also consider as the configuration which discharges exhaust gas to atmospheric air as it is. In this air supply system 30, it does not have especially an air compressor but atmospheric pressure is substantially maintained over the whole system. A sign 39 is a thermometer for detecting the temperature of the discharged air.
[0022] The water separated with the condenser 33 is sent to a tank 42. A sensor 43 is attached at least for water to a tank 42. By the sensor 43, an alarm 44 will blink and at least this water will tell an operator about a water shortage, if the water level of a tank 42 becomes below a predetermined value. It is desirable to change the capacity of a condenser 33 and to adjust the amount of recovery of water with it. That is, if the rotational frequency of the fan of a condenser 33 is raised, more water is collected and another side water becomes superfluous when water is insufficient, the rotational frequency of the fan of a condenser 33 will be fallen or stopped, and the amount of recovery of water will be lessened.
[0023] By the water supply system 40 of an example, the water supply way 45 is connected from the tank 42 to the nozzle 41 through the pump 46, the water pressure sensor 47, and the pressure regulating valve 48. The water with which it was adjusted by desired water pressure with the pressure regulating valve 48, and it had and amount of water was adjusted blows off from a nozzle 41, and becomes fog-like within an air manifold 14. And fog-like water is supplied by a self-weight, airstream, etc. of the momentum at the time of the blowdown (initial velocity), and fog all over [ of an air pole 11 ] being substantial. Supply of amount of water and water is not limited to the combination of a pressure regulating valve and a nozzle.
[0024] Thus, the water supplied to the front face of an air pole 11 takes the latent

heat from a separator front face to surrounding air, an electrode surface, and a pan, and evaporates in them there. Thereby, evaporation of the moisture of an electrolyte membrane 12 is prevented. Moreover, since the water supplied to the air pole 11 takes the latent heat also from an air pole 11, it also has the operation which cools this. When water is especially supplied at the time of starting, it can prevent that the film and a catalyst receive a damage by combustion of hydrogen and air.

[0025] The sign 50 in drawing is an ammeter and measures the current between an air pole 11 and a fuel electrode 13. The current density of drawing 1 is called for from the current measured by the ammeter 50. In this example, since resistance 51 is fixed, two poles 11 and the load (= work) applied to the body 10 of a fuel cell by measuring the current between 13 are called for. When [ both ] using fuel cell equipment for vehicles, it is desirable to obtain the load (power in which the body of a fuel cell is carrying out the current output) which measured and had the current and electrical potential difference between two poles, and has been applied to the body of a fuel cell. In for vehicles, the power required of the body of a fuel cell can be predicted from the opening of a rate, torque, or an accelerator, and the value can also be used for it.

[0026] Below, actuation of the fuel cell equipment 1 of an example is explained. Drawing 4 is the block diagram having shown the element which involves when controlling actuation of fuel cell equipment 1. Drawing 5 is the Maine flow which shows control of fuel cell equipment 1. In drawing 4 , a control device 70 and memory 73 are contained by the control box (not shown in drawing 1 ) of fuel cell equipment 1. The parameter and look-up table when performing the control program and the various control which specify actuation of the control unit 70 which consists of a computer in memory 73 are contained.

[0027] First, actuation of the hydrogen gas supply system 20 performed at step 1 of drawing 5 is explained. At the time of starting, the hydrogen exhaust valve 25 is held to close, and the hydrogen supply pressure regulating valve 23 is adjusted so that hydrogen gas may be supplied to a fuel electrode 13 by the predetermined concentration below the explosion limit. If fuel cell equipment 1 is operated where an exhaust valve 25 is closed, since the partial pressure of the hydrogen consumed with a fuel electrode 13 under the effect of N2 and O2 which are penetrated from an air pole, or generation water falls gradually, in connection with this, output voltage will also decline and the stable electrical potential difference will no longer be obtained.

[0028] Then, the gas by which the valve 25 was released based on the regulation defined beforehand, and the hydrogen partial pressure fell is exhausted, and the controlled atmosphere of a fuel electrode 13 is refreshed. The regulation defined beforehand is saved in memory 73, and a control unit 70 makes a note of the regulation concerned, and closing motion of a valve 25 and adjustment of a pressure regulating valve 23 are read from 73, and are performed.

[0029] In this example, the monitor of the output current is carried out with an ammeter 50, and if the output current declines exceeding a predetermined threshold, the predetermined time amount (for example, for 1 second) valve 25 will be released. Or where a valve 25 is made close, when fuel cell equipment 1 is

operated, the time interval to which output voltage begins to fall is measured beforehand, and closing motion control of the valve 25 is intermittently carried out so that a valve 25 may be substantially released a period the same or short a little with the time interval.

[0030] Below, actuation of the air supply system 30 performed at step 3 of drawing 5 is explained, referring to drawing 6 . A thermometer 39 detects the temperature of the exhaust air air immediately after discharging from the body 10 of a fuel cell in step 31. Since there is a possibility that the body 10 of a fuel cell may be burned when the temperature is over 80 degrees C (step 32), a fan's 38 rotational frequency is increased, and it increases (step 33), it has airflow, and the temperature of the air pole 11 which is a source of heat release is lowered. At this time, though natural, the water of a complement shall be supplied to cooling the body 10 of a fuel cell exceeding 80 degrees C to an air pole 11. When the detected temperature is 80 degrees C or less, the load of the body 10 of a fuel cell is detected (step 34). Since the relation of drawing 1 is used for control in the case of this example, the current between an air pole 11 and a fuel electrode 13 is detected. A control unit 70 calculates current density from the current value detected with the ammeter 50. And a control device 70 tests by comparison the value of the current density, and the temperature detected at step 31 in the relation of drawing 1 saved in the table format in memory 73.

[0031] For example, if the relation of the temperature and current density which were detected is the conditions of A of drawing 1 , airflow will be lowered and the operational status of the body 10 of a fuel cell will be made to shift to the conditions of B of drawing 1 . That is, the amount of supply of air is lowered even to the amount corresponding to the SUTOIKI ratio 2, and the cooling effect by the latent heat is reduced. By this, the body 10 of a fuel cell will be operated at the highest temperature, with an output (current density) maintained. In addition, in order to raise the temperature of the body 10 of a fuel cell efficiently, it is desirable to deal airflow with the SUTOIKI ratio 2 in the place where the body of a fuel cell made at the airflow original on the level as for which oxygen does not become insufficient smaller than the thing corresponding to the SUTOIKI ratio 2, sped up the programming rate at, and has approached the temperature (about 80 degrees C) of Conditions B. In addition, the relation between the amount of air supply (SUTOIKI ratio) and airflow (a fan's 38 rotational frequency) is beforehand saved in memory 1, and a control unit 70 controls a fan's 38 rotational frequency so that the airflow corresponding to the amount of air supply to calculate is obtained. For example, a servo motor drive type is used for a fan 38.

[0032] Supposing the current density of the body 10 of a fuel cell currently operated on Conditions B changes to 0.7, it is necessary to operate the body 10 of a fuel cell on Conditions C. In this case, airflow is raised to the airflow (place corresponding to the SUTOIKI ratio 5) of Conditions C, and the temperature of the body 10 of a fuel cell is lowered to the temperature (about 70 degrees C) of Conditions C. Thus, as for the operating temperature of the body 10 of a fuel cell, it is desirable to consider as the highest possible temperature in the field which can be operated.

[0033] Below, actuation of the water supply system 40 performed at step 5 of

drawing 5 is explained. The water of a tank 42 is fed with a pump 46. And the pressure is adjusted by the injection pressure regulating valve 48, and it is sprayed from a nozzle 41. By this, water will be supplied to an air pole 11 in the state of a liquid (misty condition). Of course, a pressure regulating valve 48 is omitted, the electrical potential difference impressed to a pump 46 can be adjusted, the discharge pressure of a pump 46 itself can be controlled, and desired amount of water can also be obtained more.
[0034] According to the temperature of the body of a fuel cell, the amount of supply of water is defined beforehand and is. That is, the water of the minimal dose required in order to maintain the body of a fuel cell to the temperature is supplied. It is for lessening power loss with a pump 46 as much as possible. In addition, supply of water can also be stopped if the body of a fuel cell becomes below predetermined temperature (for example, 30 degrees C). Moreover, supply of water can also be made intermittent when exceeding 30 degrees C below other predetermined temperature (for example, 50 degrees C). The relation between the temperature of the body 10 of a fuel cell and the amount of water which should be then supplied is saved in memory 73. In this example, the temperature of discharge air is first detected as shown in drawing 7 (step 51). And the amount of optimal water injection calculates based on the detected temperature (step 53). This operation is performed with reference to the relation saved in memory 73.
[0035] Next, in step 53, the optimal water pressure force corresponding to the amount of optimal water injection is calculated. For example, since there is relation indicated to be the amount of water injection and the water pressure force to drawing 8 , this relation makes a note in the form of an equation or a look-up table, and is saved beforehand 73. In this example, the pump 46 is operated by fixed power and the water pressure force of a nozzle 41 is adjusted by the opening of the pressure regulating valve 48 of a circuit 49. That is, if the opening of a pressure regulating valve 48 be large (small), the water pressure force of a nozzle 41 will become small (greatly).
[0036] Therefore, at step 54, the water pressure force applied to a nozzle 41 by the water pressure sensor 47 is detected, and a pressure regulating valve 48 is adjusted so that the water pressure force may serve as a desired value (the optimal water pressure force) by feedback control (step 55).
[0037] In addition, the water supply system 40 may be worked with fixed water pressure to predetermined every time amount progress (for example, 5 - 10 seconds).
[0038] Below, the actuation at the time of starting of the fuel cell equipment 1 of an example is explained. A pump 46 will be set to ON, if a switch (not shown) serves as ON as shown in drawing 9 (step 91) (step 93). And regardless of the operation situation (operating temperature) of the body 1 of a fuel cell, a pressure regulating valve 48 is adjusted and water is injected from a nozzle 41 so that it may become the predetermined amount of water injection (step 95). In order to protect the body 10 of a fuel cell from an anomalous reaction, amount of water injected to an air pole 11 is taken as a peak.
[0039] Then, the air supply system 30 is turned ON (step 97). At this time, a fan's 38 airflow also cools the body 10 of a fuel cell as max, and aims at prevention of an

anomalous reaction. The hydrogen supply system 20 is turned ON succeedingly (step 99). If the output of a request between an air pole 11 and a fuel electrode 15 is checked, power will be outputted outside.

[0040] In the above, operation of the air supply system 30 may be before operation of the water supply system 40. Moreover, the air supply system 30 may be worked after operation of the hydrogen supply system 20. However, before working the hydrogen supply system 20, it is necessary to work the water supply system 40. When hydrogen is supplied after the electrolyte membrane 12 has dried since air exists in the body 1 of a fuel cell irrespective of the existence of operation of the air supply system 30, there is possibility that abnormal combustion will occur. That is, when this abnormality heat occurs, before supplying hydrogen so that the body 1 of a fuel cell may not wear a damage, water is injected and the air pole 11 is wet beforehand. By carrying out like this, abnormality heat is changed to the evaporation heat of water, the humidity of an electrolyte membrane 12 is promoted further, and the damage of the body 1 of a fuel cell is prevented beforehand.

[0041] Next, other examples are explained based on drawing 10 -12. In addition, the same reference number is given to the element and step which were explained in the example as stated above, and the explanation is omitted. With the fuel cell equipment 101 of this example, a damper 138 is formed in a fan's 38 downstream. The amount of air supply is changed by making the fan 38 drive at a fixed rotational frequency, and adjusting a damper 138. Moreover, in this example, a thermometer is preferably attached in the body 10 of a fuel cell at the connector plate by the side of an air pole, and the temperature of the body 10 of a fuel cell is measured directly. Furthermore, in this example, the opening of the accelerator for vehicles is detected and a control unit 70 calculates the load required of the body 10 of a fuel cell from the detected opening at a degree ( drawing 12 , step 134). In addition, in this step 134, a control unit 70 shall change the obtained load into current density further so that the relation of drawing 1 can be used.

[0042] Since the load required of the body of a fuel cell is directly read in the condition of an accelerator according to this example, the amount of air supply can be controlled more quickly. Other operation effectiveness of this example is the same as a front example.

[0043] This invention is not limited to explanation of the gestalt of implementation of the above-mentioned invention, and an example at all. It does not deviate from the publication of a claim but deformation modes various in the range this contractor can hit on an idea of easily are also contained in this invention.

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[Translation done.]

* NOTICES *



## TECHNICAL FIELD

[Field of the Invention] This invention relates to moisture maintenance of the electrolyte layer pinched between an oxygen pole and a fuel electrode in detail about fuel cell equipment. It is suitable for the so-called PEM type which has especially the solid polymer electrolyte film of fuel cell equipment.

[Translation done.]

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## PRIOR ART

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[Description of the Prior Art] The cell proper of fuel cell equipment is a fuel electrode (it is also called a hydrogen pole when using hydrogen as a fuel electrode), and an air pole (since oxygen is reactant gas, it is also called an oxygen pole.). Moreover, while also calling it an oxidation pole, it is the configuration that the electrolyte was pinched.
[0003] Since a proton is made to conduct, if the temperature of a fuel cell becomes [ the place which needs to contain moisture ] an elevated temperature, the moisture in an electrolyte is emitted, and electrolytic resistance will become large and it will become impossible by the way, to operate the above-mentioned electrolyte.

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[Translation done.]

## TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] This invention offers the fuel cell equipment which can be efficiently operated with a simple configuration, and its operating method (the control approach).

[Translation done.]

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## MEANS

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[Means for Solving the Problem] This invention is made in view of the above-mentioned technical problem, and that configuration is as follows. Namely, the body of a fuel cell equipped with the fuel electrode and air pole which were arranged so that an electrolyte and this electrolyte might be pinched, A liquid supply means to supply a liquid to said air pole front face, and the blast weight adjustment which adjusts the blast weight which ventilates said air pole front face, While supplying the liquid by said liquid supply means by on-off control according to an operation situation detection means to detect the operation situation of said body of a fuel cell, and the detected operation situation Fuel cell equipment characterized by having the control unit which adjusts airflow by said blast weight adjustment by the change in airflow by the ON state.
[0006] Thus, according to the constituted fuel cell equipment, since the amount of supply of process air serves as adjustable, cooling using the latent heat of the water supplied to the air pole is performed fully and efficiently by changing the amount of supply of process air and making this into the optimal amount. By this, ******, as a result the body of a fuel cell will be cooled efficiently. In addition, it considers as a means to use the latent heat of water efficiently, and, as for the particle size of water, it is desirable to be referred to as 50 micrometers - 500 micrometers. As for the thickness of the electrolyte membrane of the body of a fuel cell, it is desirable that it is 200 micrometers or less. That is, the temperature of the body of a fuel cell is operated at an elevated temperature, and the amount of supply (blast weight, the air content supplied to per unit time amount, air content which passes an air chamber A (refer to drawing 3 ) to per unit time amount) of air is enlarged in the bottom to which the water of an amount is supplied enough to lower the temperature of this. By the type of immobilization of the amount of air supply, in order to use the sensible heat of water, there was fault of the need [ of supplying a lot of water ] top versatility, but even if it makes [ many ] the amount of air supply, fault is hardly produced. the load applied to air supply equipments (fan etc.) even if it makes [ many ] the amount of air supply -- amount of water -- it is because it is so small that it can ignore compared with the load which is applied in increase. The body of a fuel cell is operated at low temperature, and airflow is dropped to raise the temperature of this so that the amount of air supply may not become superfluous. Thereby, while being able to raise the temperature of the body of a fuel cell certainly, power consumed with air

supply equipment is made small as much as possible, it has it, and reduction of power loss is aimed at. Moreover, since internal temperature goes up and a temperature gradient with the open air becomes large also about the condenser for water recycle, the capacity can be made small. Furthermore, according to this invention, according to operation situations, such as an operating temperature of the body of a fuel cell, on-off control of the supply of the water which is a liquid is carried out. the overage of water can be prevented by preparing off time amount in supply of water -- both the power consumption of a liquid feeder can be reduced as much as possible. Since it is controlled by turning on and off, even if it injects a lot of water at the time of ON, the average coefficient of water absorption per unit time amount is uniformly controllable by adjusting the time amount of OFF. Water can be supplied uniformly and certainly to the whole surface of an air pole by making a lot of water inject at the time of ON. Thus, it becomes possible by controlling the blast weight of air, and/or the amount of supply of a liquid to store the operation situation (operating temperature) of the body of a fuel cell within the limits of predetermined. Instead water can be alike, or it can use together with water, and liquids, such as alcohol, can be used.
[0007] According to this invention, since the amount of supply of air and the amount of supply of water have been independent, compared with the supply system which they have not been independent of, the required amount of supply is [ each of air and water ] controllable [ independently ] by required timing. There is no futility and the output of a high fuel cell is efficiently obtained by that. Moreover, since the amount of the air and water to collect can also be made into the minimum, a condenser can also be made small and also becomes saving of the power consumption by the accessory vessel. Moreover, the time amount concerning starting can also be shortened.
[0008] Drawing 1 shows the relation on the theory of the load (current density) of the body of a fuel cell and temperature (air exhaust-gas temperature) in each SUTOIKI ratio. The air content supplied here at an air pole on the basis of the process air content which contains the amount of oxygen on the theory consumed at a fuel cell reaction with a SUTOIKI ratio is specified. Therefore, when a SUTOIKI ratio is 1, it is the case where the minimum required air content is sent theoretically, and if a SUTOIKI ratio is set to 2, the amount of air supply will become the twice at the time of the SUTOIKI ratio 1. It turns out that the body of a fuel cell can be operated at high temperature although such same load that there are so few amounts of air supply that a SUTOIKI ratio is small than drawing 1 is obtained. Effectiveness becomes higher as the operating temperature of the body of a fuel cell has this high. Moreover, since the temperature of discharge air also goes up by the elevated-temperature operation, capacity of a condenser can also be made small. Therefore, it is desirable to operate the body of a fuel cell at the highest temperature that can provide the load demanded. Since the temperature of a load and the body of a fuel cell is uniquely decided on by the SUTOIKI ratio, what is necessary will be to detect one side of a load and temperature and just to decide the SUTOIKI ratio of air supply, i.e., the amount, (amount strictly supplied to an air chamber inlet port).
[0009] However, in the present fuel cell, the operating temperature and SUTOIKI

ratio (the amount of air supply) of the body of a fuel cell have various kinds of limits. For example, in order to prevent printing of the body of a fuel cell certainly, it is necessary to make the operating temperature into 100-80 degrees C or less. Moreover, according to examination of this invention persons, operation on the conditions above the broken line L shown in drawing 1 was impossible. This is presumed to be what is depended on the reason of air not reaching an air pole enough for resistance of an air supply way or a gaseous diffusion layer, the capacity of a catalyst, etc., when there are few amounts of air supply (when airflow is small). Therefore, in drawing 1 , it is 80 degrees C or less, and the body of a fuel cell can be operated in the field below a broken line L (predetermined within the limits). And if the effectiveness is taken into consideration, it is desirable to operate this on the maximum-temperature edge of the field concerned which can be operated.

[0010] With the fuel cell equipment for vehicles with an intense load effect, the amount of air supply is changed according to the load demanded. It is desirable to adjust the amount of air supply so that it may become the maximum temperature which detects the temperature of the body of a fuel cell to coincidence then, and can realize the demanded load, i.e., the minimum SUTOIKI ratio, (the amount of air supply). What is necessary is to supervise only the temperature of the body of a fuel cell substantially, and to adjust the amount of air supply in the fuel cell equipment used in the environment where a load is hardly changed, on the other hand, so that this may serve as desired temperature only when the temperature is changed. That is, when the temperature of the body of a fuel cell becomes lower than a desired temperature requirement, the cooling effect which was made to reduce the amount of air supply and used the latent heat of water is lowered, and when the temperature of the body of an another side fuel cell becomes higher than a desired temperature requirement, the cooling effect which increased the amount of air supply and used the latent heat of water is raised. Various limits are imposed on the service condition of fuel cell equipment with an external environment or the engine performance of auxiliary machinery. It may be restricted to the field square [ of the body of a fuel cell / in the condition field in drawing 1 which can be operated ] and shown depending on the case. In this field, the operating temperature of the body of a fuel cell does not exceed Rhine of the SUTOIKI ratio 1 (in order to always work the body of a fuel cell, the air content corresponding to the SUTOIKI ratio 1 shall always be supplied at least). Therefore, it is not necessary to supervise the temperature of the body of a fuel cell. Therefore, only a load is supervised and the air of the minimum amount in which an output is possible is supplied in the load concerned.

[0011] the above -- in the case of which, the water of always sufficient amount for an air pole shall be supplied That is, even if there are some which evaporate with the heat of the body of a fuel cell, liquid-like water shall always exist in an air pole and its perimeter (namely, inside of an air chamber) during operation of fuel cell equipment. Thus, since water always exists in an air pole, as a result of being able to use the latent heat of water efficiently, a cooling plate can be thinned out from the stack of the body of a fuel cell, or this can be omitted. It is desirable to equip the stack of the body of a fuel cell with the cooling system of a cooling plate or a

cooling pipe, and others in consideration of the case where there is a possibility that evaporation of sufficient quantity of water may not be securable. The heat of a stack can be taken out outside with the heat carrier (usually water) which circulates to this cooling system, and it can use for heating in the car etc. (use as the so-called KOJIENE).
[0012] In the above, process air is supplied to an air pole, without being compressed substantially. In addition, this invention is also applicable to the fuel cell equipment of a type equipped with the pressurized oxidation gas supply system. When an oxidation gas supply system is equipped with the compressor of oxidation gas, also when the inside of a system serves as a pressure higher than atmospheric pressure by duct resistance of gas piping, it is contained in the pressurized oxidation gas supply system concerned from the first. Although the temperature of the body of a fuel cell attaches a thermometer to the body of a fuel cell concerned and this can be measured of course, as shown in drawing 1 , it is also possible by measuring the temperature of exhaust air air to measure the temperature indirectly. In this case, it is desirable to measure the temperature of the air immediately after discharging from the body of a fuel cell. Based on such temperature, the operation situation of the body of a fuel cell is detected. A thermometer serves as an operation situation detection means. The loads of the body of a fuel cell are a current between the two poles of the body of a fuel cell, and the product of an electrical potential difference. As a parameter considered as reference when controlling the amount of supply of process air, the present load which the body of a fuel cell is outputting actually can be detected, and this can be used. In addition, the opening of the load required of the body of a fuel cell at a degree, for example, a rate, torque, or an accelerator can be detected, and this can also be used as the parameter concerned.

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[Translation done.]

## EXAMPLE

[Example] Next, the example of this invention is explained. Drawing 2 shows the outline configuration of the fuel cell equipment 1 of an example. Drawing 3 shows the basic unit of the body 10 of a fuel cell. As shown in drawing 2 , the outline configuration of this equipment 1 is carried out from the body 10 of a fuel cell, the hydrogen gas supply system 20 as fuel gas, the air supply system 30, and the water supply system 40.
[0014] The unit unit of the body 10 of a fuel cell is the configuration which pinched the solid-state polyelectrolyte film 12 with the air pole 11 and the fuel electrode 13. With actual equipment, two or more sheet laminating of this unit unit is carried out (fuel cell stack). The air manifolds 14 and 15 for inhaling and exhausting air, respectively are formed in the upper part of an air pole 11, and a lower part. The mounting hole for attaching a nozzle 41 is formed in the upper manifold 14. In order for the jet include angle of the water which blows off from a nozzle 41 to have a limit, and to make water into the shape of a fog and to spread this all over an air pole 11, predetermined spacing is needed between a nozzle and an air pole 11. Therefore, this manifold 14 becomes what has the comparatively high back. On the other hand, the lower air manifold 15 shall discharge the dropped water efficiently. In addition, a nozzle can also be prepared in the side face of a manifold 14. The water which blows off from this nozzle will spread the whole region in a manifold 14, and, therefore, will spread all over an air pole 11. By preparing a nozzle in the side face of a manifold 14, a low manifold is employable. Therefore, the miniaturization of the body of a fuel cell can be attained.
[0015] As for a nozzle, it is desirable to inject direct water towards an air pole front face. Thereby, the water of a desired amount can be supplied to an air pole front face regardless of the amount of air supply. That is, it becomes controllable independently about the amount of supply of air, and the amount of supply of water (independent supply type). According to this independent supply type, also in the condition of the big amounts of air supply (airflow), such as the time of starting, the water of the amount of requests can be certainly supplied to an air pole front face. Therefore, compaction of warm-up time can be aimed at. Waterdrop is emitted into airstream and the amount of air supply and the water amount of supply cannot be controlled independently by the type which puts this on airstream and is supplied to an air pole (un-independent supply type). Modification of the amount of air supply and modification of the water amount of supply are not always

required of coincidence, and those modification may be needed independently. For example, when only the amount of supply of air needs to be changed and even the amount of supply of water is changed, there is a possibility of the response of control of the body of a fuel cell becoming late, as a result causing the loss of power of fuel cell equipment. On the other hand, since the water and/or air of a complement can be supplied to required timing, the body of a fuel cell is efficiently controllable by the independent supply type which this invention adopts. Moreover, supply of useless air and useless water is avoided by controlling supply of water and air independently. It also sets at this point and is ** with efficient operation of the body of a fuel cell. Furthermore, capacity of a condenser can also be made small by avoiding supply of useless water or useless air.

[0016] As shown in drawing 3 , the unit unit of the above-mentioned air pole 11-solid-state polyelectrolyte film 12-fuel electrode 13 has the shape of thin film, and is pinched with the connector plates 16 and 17 made from carbon of a pair. The slot 18 for circulating air is formed in the field of the connector plate 16 which counters an air pole 11 two or more articles. Each slot 18 is formed in the vertical direction, and is opening manifolds 14 and 15 for free passage. Consequently, the water of the shape of a fog supplied from a nozzle 41 reaches to the lower part of an air pole 11 along the slot 18 concerned. An air chamber A is constituted by the peripheral surface of this slot 18, and the expressional side of an air pole 11. Illustration top opening of an air chamber A is the inlet port (upstream opening) of ventilation, and opening of the illustration bottom is the outlet (downstream opening) of ventilation. It is desirable to form a thermometer so that the exhaust-gas temperature of this outlet may be detected. Although it is the configuration which liquids, such as water, are made to blow off directly to upstream opening, and supplies them in the example, liquids, such as water, can also be supplied from downstream opening. Furthermore, the through tube of an illustration longitudinal direction can be formed in a connector plate, and liquids, such as water, can also be supplied to an air chamber A from here. Thus, the supplied water evaporates chiefly in the field (the peripheral surface of a slot 18, and the expressional side of an air pole 11: these tend [ comparatively ] to become an elevated temperature) which constitutes an air chamber A. Similarly, the slot 19 for circulating hydrogen gas is formed in the field of the connector plate 17 which counters a fuel electrode 13. In the example, two or more articles of this slot 19 were formed horizontally. A combustion chamber B is formed in respect of expression of the peripheral surface of this slot 19, and the connector plate 17. Water can also be supplied to this combustion chamber B by the same approach as the air chamber A as stated above.

[0017] Since water is supplied to an air pole 11, this is formed with an ingredient with a water resisting property. Moreover, since the effective area of an air pole 11 will decrease if the film of water is made there, high water repellence is also required of the ingredient of an air pole 11. The carbon cross was applied as this ingredient, (C+PTFE) was applied as a base material, and the crowded gaseous diffusion layer was used. The thin film of general-purpose Nafion (trade name: Du Pont) was used for the solid-state polyelectrolyte film 12. In addition, if the reverse osmosis of the generation water from an air pole side is possible for

membranous thickness, it will be good, for example, will be set to 20-200 micrometers. The fuel electrode 13 is formed with the same structure as an air pole 11. Structure may be changed by the fuel electrode 13 and the air pole 11.
[0018] Homogeneity distributes, respectively and the well-known platinum system catalyst used in order to promote the reaction of oxygen and hydrogen as it is also at a certain amount of thickness is formed in the field of the direction which contacts an electrolyte membrane 12 in an air pole 11 and a fuel electrode 13 as a catalyst bed in an air pole 11 and a fuel electrode 13.
[0019] As a hydrogen feeder 21 of the hydrogen gas supply system 20, the hydrogen bomb which consists of a hydrogen storing metal alloy was used in this example. in addition, the reforming reaction of the reforming raw materials, such as a hydrogen bomb of liquid hydrogen, and water / methanol mixed liquor, is carried out with a reforming vessel -- making -- hydrogen -- rich reformed gas is made to generate, this reformed gas is stored in the tank, and this can also be made into the source of hydrogen. Hydrogen piping can be made into the source of hydrogen when using fuel cell equipment 1, fixing indoors. The hydrogen feeder 21 and the fuel electrode 13 are connected by the hydrogen gas supply way 22 through the hydrogen supply pressure regulating valve 23. A pressure regulating valve 23 adjusts the flow rate of the hydrogen gas supplied to a fuel electrode 13, and can use the thing of a general-purpose configuration.
[0020] The exhaust gas from a fuel electrode 13 is discharged to the open air. In addition, this exhaust gas can be supplied to an air manifold, and it can also mix with air here.
[0021] Air is supplied to an air pole 11 by the fan 38 from the inside of atmospheric air. The sign 31 of drawing is the supply way of air, and is connected with the manifold 14 of an air pole 11. The air conduit 32 for circulating through or exhausting the air which passed the air pole 11 is connected with the lower manifold 15, and exhaust gas is sent to the exhaust air way 36 through the condenser 33 which separates water. The amount exhausted by the opening of the air exhaust air pressure regulating valve 34 from the exhaust air way 36 is adjusted. Moreover, the exhaust air pressure regulating valve 34 can be omitted, and it can also consider as the configuration which discharges exhaust gas to atmospheric air as it is. In this air supply system 30, it does not have especially an air compressor but atmospheric pressure is substantially maintained over the whole system. A sign 39 is a thermometer for detecting the temperature of the discharged air.
[0022] The water separated with the condenser 33 is sent to a tank 42. A sensor 43 is attached at least for water to a tank 42. By the sensor 43, an alarm 44 will blink and at least this water will tell an operator about a water shortage, if the water level of a tank 42 becomes below a predetermined value. It is desirable to change the capacity of a condenser 33 and to adjust the amount of recovery of water with it. That is, if the rotational frequency of the fan of a condenser 33 is raised, more water is collected and another side water becomes superfluous when water is insufficient, the rotational frequency of the fan of a condenser 33 will be fallen or stopped, and the amount of recovery of water will be lessened.
[0023] By the water supply system 40 of an example, the water supply way 45 is

connected from the tank 42 to the nozzle 41 through the pump 46, the water pressure sensor 47, and the pressure regulating valve 48. The water with which it was adjusted by desired water pressure with the pressure regulating valve 48, and it had and amount of water was adjusted blows off from a nozzle 41, and becomes fog-like within an air manifold 14. And fog-like water is supplied by a self-weight, airstream, etc. of the momentum at the time of the blowdown (initial velocity), and fog all over [ of an air pole 11 ] being substantial. Supply of amount of water and water is not limited to the combination of a pressure regulating valve and a nozzle.
[0024] Thus, the water supplied to the front face of an air pole 11 takes the latent heat from a separator front face to surrounding air, an electrode surface, and a pan, and evaporates in them there. Thereby, evaporation of the moisture of an electrolyte membrane 12 is prevented. Moreover, since the water supplied to the air pole 11 takes the latent heat also from an air pole 11, it also has the operation which cools this. When water is especially supplied at the time of starting, it can prevent that the film and a catalyst receive a damage by combustion of hydrogen and air.
[0025] The sign 50 in drawing is an ammeter and measures the current between an air pole 11 and a fuel electrode 13. The current density of drawing 1 is called for from the current measured by the ammeter 50. In this example, since resistance 51 is fixed, two poles 11 and the load (= work) applied to the body 10 of a fuel cell by measuring the current between 13 are called for. When [ both ] using fuel cell equipment for vehicles, it is desirable to obtain the load (power in which the body of a fuel cell is carrying out the current output) which measured and had the current and electrical potential difference between two poles, and has been applied to the body of a fuel cell. In for vehicles, the power required of the body of a fuel cell can be predicted from the opening of a rate, torque, or an accelerator, and the value can also be used for it.
[0026] Below, actuation of the fuel cell equipment 1 of an example is explained. Drawing 4 is the block diagram having shown the element which involves when controlling actuation of fuel cell equipment 1. Drawing 5 is the Maine flow which shows control of fuel cell equipment 1. In drawing 4 , a control device 70 and memory 73 are contained by the control box (not shown in drawing 1 ) of fuel cell equipment 1. The parameter and look-up table when performing the control program and the various control which specify actuation of the control unit 70 which consists of a computer in memory 73 are contained.
[0027] First, actuation of the hydrogen gas supply system 20 performed at step 1 of drawing 5 is explained. At the time of starting, the hydrogen exhaust valve 25 is held to close, and the hydrogen supply pressure regulating valve 23 is adjusted so that hydrogen gas may be supplied to a fuel electrode 13 by the predetermined concentration below the explosion limit. If fuel cell equipment 1 is operated where an exhaust valve 25 is closed, since the partial pressure of the hydrogen consumed with a fuel electrode 13 under the effect of N2 and O2 which are penetrated from an air pole, or generation water falls gradually, in connection with this, output voltage will also decline and the stable electrical potential difference will no longer be obtained.
[0028] Then, the gas by which the valve 25 was released based on the regulation

defined beforehand, and the hydrogen partial pressure fell is exhausted, and the controlled atmosphere of a fuel electrode 13 is refreshed. The regulation defined beforehand is saved in memory 73, and a control unit 70 makes a note of the regulation concerned, and closing motion of a valve 25 and adjustment of a pressure regulating valve 23 are read from 73, and are performed.
[0029] In this example, the monitor of the output current is carried out with an ammeter 50, and if the output current declines exceeding a predetermined threshold, the predetermined time amount (for example, for 1 second) valve 25 will be released. Or where a valve 25 is made close, when fuel cell equipment 1 is operated, the time interval to which output voltage begins to fall is measured beforehand, and closing motion control of the valve 25 is intermittently carried out so that a valve 25 may be substantially released a period the same or short a little with the time interval.
[0030] Below, actuation of the air supply system 30 performed at step 3 of drawing 5 is explained, referring to drawing 6 . A thermometer 39 detects the temperature of the exhaust air air immediately after discharging from the body 10 of a fuel cell in step 31. Since there is a possibility that the body 10 of a fuel cell may be burned when the temperature is over 80 degrees C (step 32), a fan's 38 rotational frequency is increased, and it increases (step 33), it has airflow, and the temperature of the air pole 11 which is a source of heat release is lowered. At this time, though natural, the water of a complement shall be supplied to cooling the body 10 of a fuel cell exceeding 80 degrees C to an air pole 11. When the detected temperature is 80 degrees C or less, the load of the body 10 of a fuel cell is detected (step 34). Since the relation of drawing 1 is used for control in the case of this example, the current between an air pole 11 and a fuel electrode 13 is detected. A control unit 70 calculates current density from the current value detected with the ammeter 50. And a control device 70 tests by comparison the value of the current density, and the temperature detected at step 31 in the relation of drawing 1 saved in the table format in memory 73.
[0031] For example, if the relation of the temperature and current density which were detected is the conditions of A of drawing 1 , airflow will be lowered and the operational status of the body 10 of a fuel cell will be made to shift to the conditions of B of drawing 1 . That is, the amount of supply of air is lowered even to the amount corresponding to the SUTOIKI ratio 2, and the cooling effect by the latent heat is reduced. By this, the body 10 of a fuel cell will be operated at the highest temperature, with an output (current density) maintained. In addition, in order to raise the temperature of the body 10 of a fuel cell efficiently, it is desirable to deal airflow with the SUTOIKI ratio 2 in the place where the body of a fuel cell made at the airflow original on the level as for which oxygen does not become insufficient smaller than the thing corresponding to the SUTOIKI ratio 2, sped up the programming rate at, and has approached the temperature (about 80 degrees C) of Conditions B. In addition, the relation between the amount of air supply (SUTOIKI ratio) and airflow (a fan's 38 rotational frequency) is beforehand saved in memory 1, and a control unit 70 controls a fan's 38 rotational frequency so that the airflow corresponding to the amount of air supply to calculate is obtained. For example, a servo motor drive type is used for a fan 38.

[0032] Supposing the current density of the body 10 of a fuel cell currently operated on Conditions B changes to 0.7, it is necessary to operate the body 10 of a fuel cell on Conditions C. In this case, airflow is raised to the airflow (place corresponding to the SUTOIKI ratio 5) of Conditions C, and the temperature of the body 10 of a fuel cell is lowered to the temperature (about 70 degrees C) of Conditions C. Thus, as for the operating temperature of the body 10 of a fuel cell, it is desirable to consider as the highest possible temperature in the field which can be operated.
[0033] Below, actuation of the water supply system 40 performed at step 5 of drawing 5 is explained. The water of a tank 42 is fed with a pump 46. And the pressure is adjusted by the injection pressure regulating valve 48, and it is sprayed from a nozzle 41. By this, water will be supplied to an air pole 11 in the state of a liquid (misty condition). Of course, a pressure regulating valve 48 is omitted, the electrical potential difference impressed to a pump 46 can be adjusted, the discharge pressure of a pump 46 itself can be controlled, and desired amount of water can also be obtained more.
[0034] According to the temperature of the body of a fuel cell, the amount of supply of water is defined beforehand and is. That is, the water of the minimal dose required in order to maintain the body of a fuel cell to the temperature is supplied. It is for lessening power loss with a pump 46 as much as possible. In addition, supply of water can also be stopped if the body of a fuel cell becomes below predetermined temperature (for example, 30 degrees C). Moreover, supply of water can also be made intermittent when exceeding 30 degrees C below other predetermined temperature (for example, 50 degrees C). The relation between the temperature of the body 10 of a fuel cell and the amount of water which should be then supplied is saved in memory 73. In this example, the temperature of discharge air is first detected as shown in drawing 7 (step 51). And the amount of optimal water injection calculates based on the detected temperature (step 53). This operation is performed with reference to the relation saved in memory 73.
[0035] Next, in step 53, the optimal water pressure force corresponding to the amount of optimal water injection is calculated. For example, since there is relation indicated to be the amount of water injection and the water pressure force to drawing 8 , this relation makes a note in the form of an equation or a look-up table, and is saved beforehand 73. In this example, the pump 46 is operated by fixed power and the water pressure force of a nozzle 41 is adjusted by the opening of the pressure regulating valve 48 of a circuit 49. That is, if the opening of a pressure regulating valve 48 be large (small), the water pressure force of a nozzle 41 will become small (greatly).
[0036] Therefore, at step 54, the water pressure force applied to a nozzle 41 by the water pressure sensor 47 is detected, and a pressure regulating valve 48 is adjusted so that the water pressure force may serve as a desired value (the optimal water pressure force) by feedback control (step 55).
[0037] In addition, the water supply system 40 may be worked with fixed water pressure to predetermined every time amount progress (for example, 5 - 10 seconds).
[0038] Below, the actuation at the time of starting of the fuel cell equipment 1 of

an example is explained. A pump 46 will be set to ON, if a switch (not shown) serves as ON as shown in drawing 9 (step 91) (step 93). And regardless of the operation situation (operating temperature) of the body 1 of a fuel cell, a pressure regulating valve 48 is adjusted and water is injected from a nozzle 41 so that it may become the predetermined amount of water injection (step 95). In order to protect the body 10 of a fuel cell from an anomalous reaction, amount of water injected to an air pole 11 is taken as a peak.
[0039] Then, the air supply system 30 is turned ON (step 97). At this time, a fan's 38 airflow also cools the body 10 of a fuel cell as max, and aims at prevention of an anomalous reaction. The hydrogen supply system 20 is turned ON succeedingly (step 99). If the output of a request between an air pole 11 and a fuel electrode 15 is checked, power will be outputted outside.
[0040] In the above, operation of the air supply system 30 may be before operation of the water supply system 40. Moreover, the air supply system 30 may be worked after operation of the hydrogen supply system 20. However, before working the hydrogen supply system 20, it is necessary to work the water supply system 40. When hydrogen is supplied after the electrolyte membrane 12 has dried since air exists in the body 1 of a fuel cell irrespective of the existence of operation of the air supply system 30, there is possibility that abnormal combustion will occur. That is, when this abnormality heat occurs, before supplying hydrogen so that the body 1 of a fuel cell may not wear a damage, water is injected and the air pole 11 is wet beforehand. By carrying out like this, abnormality heat is changed to the evaporation heat of water, the humidity of an electrolyte membrane 12 is promoted further, and the damage of the body 1 of a fuel cell is prevented beforehand.
[0041] Next, other examples are explained based on drawing 10 -12. In addition, the same reference number is given to the element and step which were explained in the example as stated above, and the explanation is omitted. With the fuel cell equipment 101 of this example, a damper 138 is formed in a fan's 38 downstream. The amount of air supply is changed by making the fan 38 drive at a fixed rotational frequency, and adjusting a damper 138. Moreover, in this example, a thermometer is preferably attached in the body 10 of a fuel cell at the connector plate by the side of an air pole, and the temperature of the body 10 of a fuel cell is measured directly. Furthermore, in this example, the opening of the accelerator for vehicles is detected and a control unit 70 calculates the load required of the body 10 of a fuel cell from the detected opening at a degree ( drawing 12 , step 134). In addition, in this step 134, a control unit 70 shall change the obtained load into current density further so that the relation of drawing 1 can be used.
[0042] Since the load required of the body of a fuel cell is directly read in the condition of an accelerator according to this example, the amount of air supply can be controlled more quickly. Other operation effectiveness of this example is the same as a front example.
[0043] This invention is not limited to explanation of the gestalt of implementation of the above-mentioned invention, and an example at all. It does not deviate from the publication of a claim but deformation modes various in the range this contractor can hit on an idea of easily are also contained in this invention.

[Translation done.]

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the graph which shows the relation between the current density (load) of the body of a fuel cell, an air exhaust-gas temperature (temperature of the body itself), and a SUTOIKI ratio (the amount of air supply).
[Drawing 2] It is the mimetic diagram showing the configuration of the fuel cell equipment of the example of the location of this invention.
[Drawing 3] It is the sectional view showing the basic configuration of the body of a fuel cell similarly.
[Drawing 4] It is the mimetic diagram showing the control system of fuel cell equipment similarly.
[Drawing 5] It is the Maine flow which similarly shows actuation of fuel cell equipment.
[Drawing 6] It is the flow chart which similarly shows actuation of an air supply system.
[Drawing 7] It is the flow chart which similarly shows actuation of a water supply system.
[Drawing 8] It is the graphical representation showing the amount of water injection, and the relation of the water pressure force similarly.
[Drawing 9] It is the flow chart which similarly shows the control at the time of starting.
[Drawing 10] It is the mimetic diagram showing the configuration of the fuel cell equipment of other examples of this invention.
[Drawing 11] It is the mimetic diagram showing a control system similarly.
[Drawing 12] It is the flow chart which similarly shows actuation of an air supply system.
[Description of Notations]
1,101 Fuel cell equipment
10 Body of Fuel Cell
11 Air Pole
30 Air Supply System
38 Fan
39,139 Thermometer
40 Water Supply System
50 Ampere Meter

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[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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## DRAWINGS

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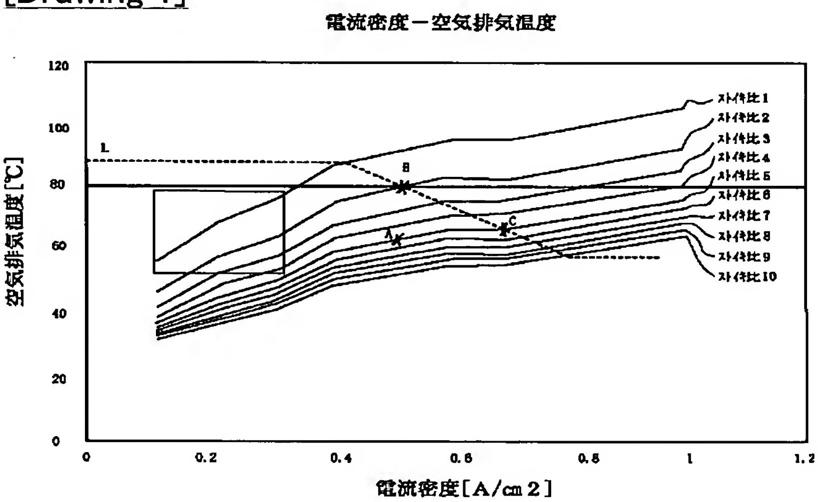
[Drawing 1]

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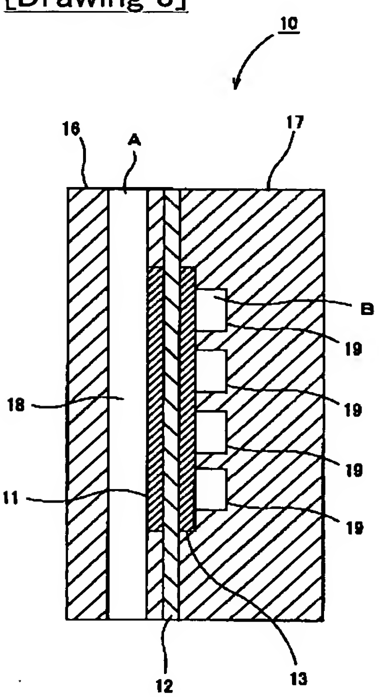

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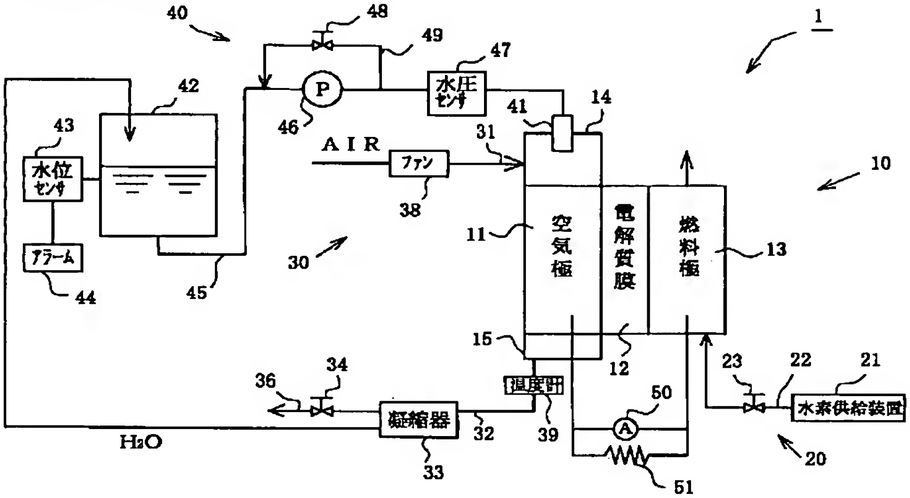


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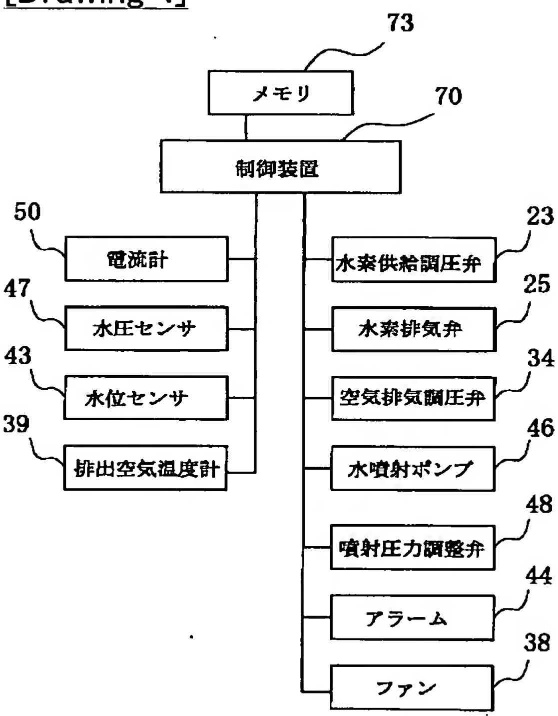


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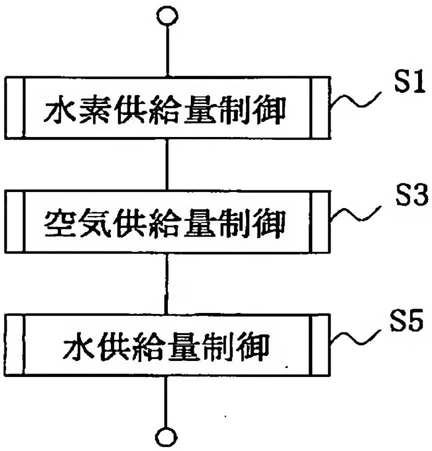


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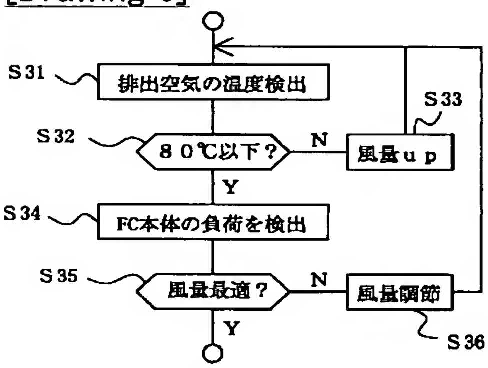
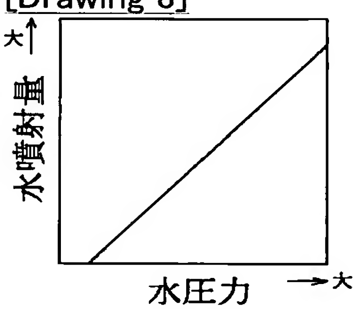
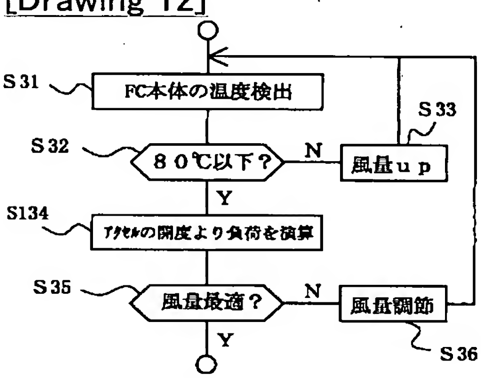



[Drawing 8]




[Drawing 12]

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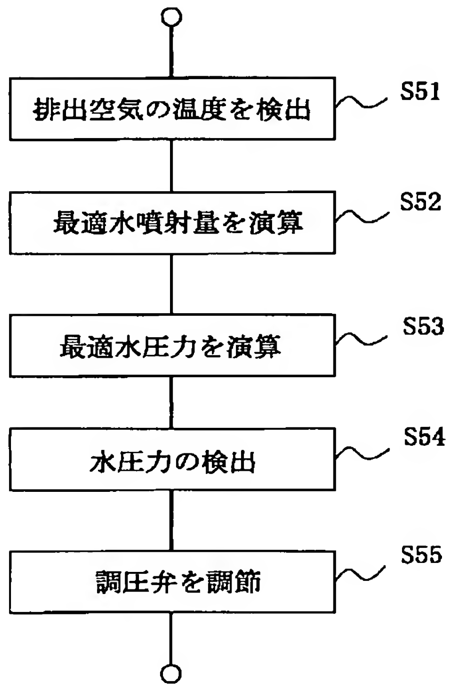
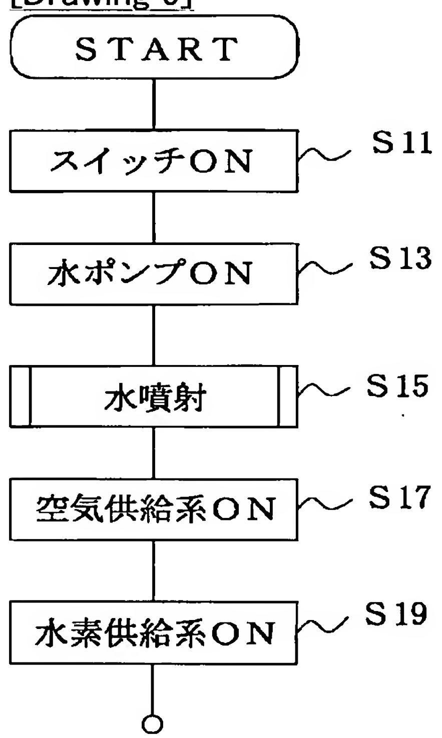
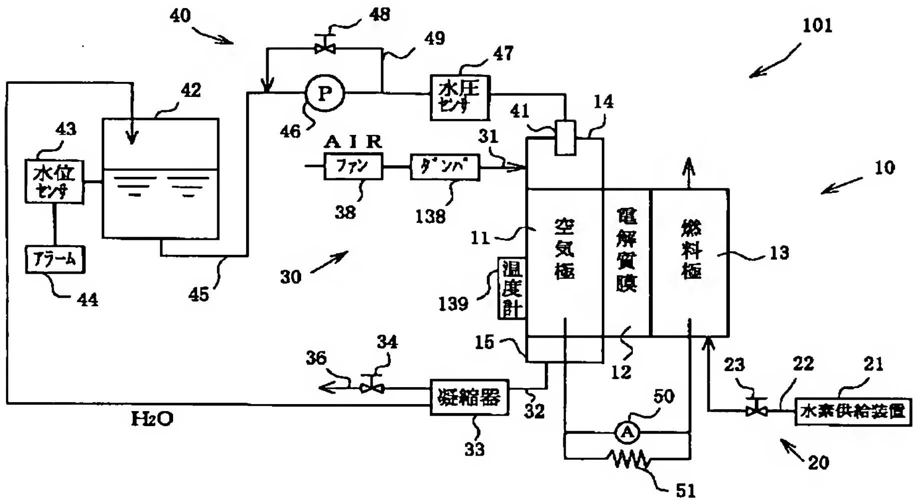


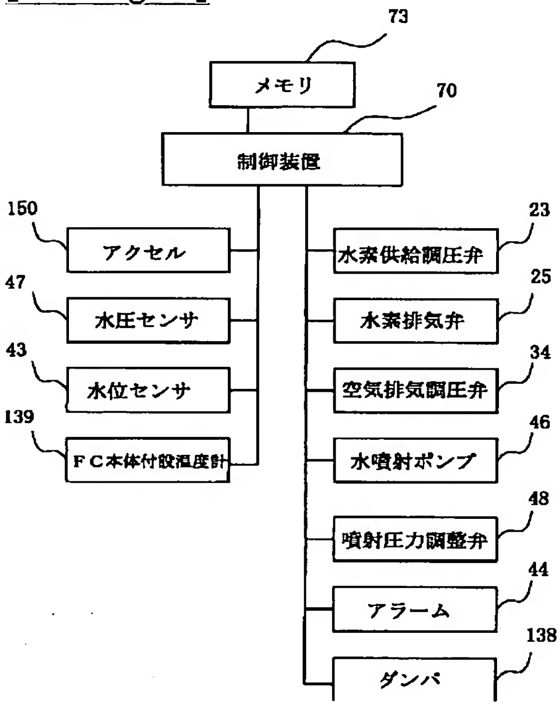

[Drawing 9]




[Drawing 10]




[Drawing 11]

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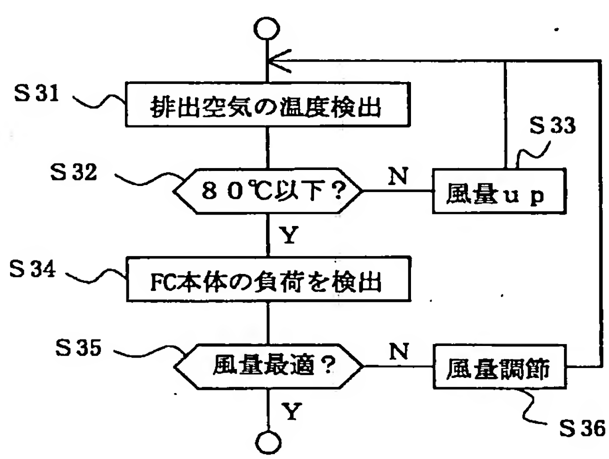
(54)【発明の名称】　燃料電池装置

(57)【要約】　（修正有）

【課題】　高分子固体電解質膜を有するいわゆるＰＥＭ型の燃料電池電解質は、プロトンを伝導させせるので、水分を含んでいる必要がある、ところが、燃料電池の温度が高温になると、電解質中の水分が放出され、電解質の抵抗が大きくなり、運転できなくなってしまう。本発明は、簡易な構成で効率よく運転できる燃料電池装置及びその運転方法（制御方法）を提供するものである。

【解決手段】　燃料電池本体の運転状況を検出し、検出された運転状況に応じて空気極へ供給される水の供給をオンオフ制御で行うとともに、空気極への送風調節をオン状態で風量の増減で行う。例えば、燃料電池本体の排気温度が低い場合には、前記水供給手段による水の供給を停止するとともに、排気温度が高い場合には、前記水供給手段による液体の供給をおこなう。排気温度が低い場合には、前記送風量調節装置による送風量を小さくするとともに、排気温度が高い場合には、前記送風量調節装置による送風量を大きくする。



【特許請求の範囲】

【請求項１】　電解質と該電解質を挟持するように配設された燃料極及び空気極とを備えた燃料電池本体と、
前記空気極表面に液体を供給する液体供給手段と、
前記空気極表面に送風する送風量を調節する送風量調節装置と、
前記燃料電池本体の運転状況を検出する運転状況検出手段と、
検出された運転状況に応じて、前記液体供給手段による液体の供給をオンオフ制御で行うとともに、前記送風量調節装置による風量の調節をオン状態で風量の増減で行う制御装置を備えたことを特徴とする燃料電池装置。

【請求項２】　前記空気極は、送風の入口と出口を備え、前記運転状況検出手段の検出する運転状況は、前記出口の排気温度であることを特徴とする請求項１に記載の燃料電池装置。

【請求項３】　前記制御装置は、排気温度が低い場合には、前記液体供給手段による液体の供給を停止するとともに、排気温度が高い場合には、前記液体供給手段による液体の供給をおこなう、ことを特徴とする請求項２に記載の燃料電池装置。

【請求項４】　前記制御装置は、排気温度が低い場合には、前記送風量調節装置による送風量を小さくするとともに、排気温度が高い場合には、前記送風量調節装置による送風量を大きくする、ことを特徴とする請求項２又は３に記載の燃料電池装置。

【請求項５】　前記運転状況検出手段は、前記燃料電池本体の運転温度を検出し、前記制御装置は、前記運転温度が所定の範囲内になるように制御する、ことを特徴とする請求項１に記載の燃料電池装置。

【請求項６】　前記燃料電池本体の運転温度が低い場合は、前記液体供給手段による液体の供給を停止する、ことを特徴とする請求項５に記載の燃料電池装置。

【請求項７】　前記燃料電池本体の始動の際には、運転温度に無関係に前記液体供給手段よる液体の供給を行うとともに、始動の終了後は、運転温度に対応して前記液体供給手段による液体の供給を行う、ことを特徴とする請求項５又は６に記載の燃料電池装置。

【請求項８】　電解質と該電解質を挟持するように配設された燃料極及び空気極とを備えた燃料電池本体と、
前記空気極表面に液体を供給する液体供給手段と、
前記空気極表面に送風する送風量を調節する送風量調節装置と、
前記燃料電池本体の運転温度を検出する運転温度検出手段と、
運転温度が所定値以上の場合に液体を供給し、前記所定値未満の場合に液体の供給を停止するように前記液体供給手段を制御する液体供給制御装置と、
運転温度に対応して前記送風量調節装置による風量の調節を制御する送風量制御装置を備えたことを特徴とする燃料電池装置。

【請求項９】　前記液体供給装置は、運転温度が所定値以下の場合に、間欠的に液体を供給することを特徴とする請求項８に記載の燃料電池装置。

【請求項１０】　前記液体供給制御装置は、前記燃料電池本体の始動の際には、運転温度に無関係に前記液体供給手段による液体の供給を行うとともに、始動の終了後は、運転温度に対応して前記液体供給手段による液体の供給を行う、ことを特徴とする請求項８に記載の燃料電池装置。

【請求項１１】　電解質と該電解質を挟持するように配設された燃料極及び空気極とを備えた燃料電池本体に対し前記空気極表面に液体を供給するとともに、前記空気極表面に空気を送風する構成の燃料電池装置を制御する方法であって、
前記燃料電池本体の運転状況を検出し、検出された運転状況に応じて前記液体の供給をオンオフ制御で行うとともに、風量の調節をオン状態で風量の増減で行うことを特徴とする燃料電池装置の制御方法。

【請求項１２】　前記空気極出口の排気温度に基づき前記運転状況を検出する、ことを特徴とする請求項１１に記載の制御方法。

【請求項１３】　排気温度が低い場合には、前記液体の供給を停止するとともに、排気温度が高い場合には、前記液体の供給をおこなう、ことを特徴とする請求項１２に記載の制御方法。

【請求項１４】　排気温度が低い場合には、送風量を小さくするとともに、排気温度が高い場合には、送風量を大きくする、ことを特徴とする請求項１２又は１３に記載の制御方法。

【請求項１５】　前記燃料電池本体の運転温度に基づき前記運転状況を検出する、ことを特徴とする請求項１１に記載の制御方法。

【請求項１６】　前記燃料電池本体の運転温度が低い場合は、液体の供給を停止する、ことを特徴とする請求項１５に記載の制御方法。

【請求項１７】　前記燃料電池本体の始動の際には、運転温度に無関係に前記液体の供給を行うとともに、始動の終了後は、運転温度に対応して前記液体の供給を行う、ことを特徴とする請求項１５又は１６に記載の制御方法。

【請求項１８】　電解質と該電解質を挟持するように配設された燃料極及び空気極とを備えた燃料電池本体に対し前記空気極表面に液体を供給するとともに、前記空気極表面に空気を送風する構成の燃料電池装置を制御する方法であって、
前記燃料電池本体の運転温度を検出し、検出された前記運転温度が所定値以上の場合に液体を供給し、前記所定値未満の場合に液体の供給を停止し、
検出された前記運転温度に対応して送風量を調節する、

ことを特徴とする燃料電池装置の制御方法。

【請求項１９】　検出された前記運転温度が所定値以下の場合に、間欠的に液体を供給することを特徴とする請求項１８に記載の制御方法。

【請求項２０】　前記燃料電池本体の始動の際には、検出された前記運転温度に無関係に前記液体の供給を行うとともに、始動の終了後は、検出された前記運転温度に対応して液体の供給を行う、ことを特徴とする請求項１８に記載の制御方法。

【請求項２１】　前記液体は水である、ことを特徴とする請求項１～１０のいずれかに記載の燃料電池装置。

【請求項２２】　前記液体は水である、ことを特徴とする請求項１１～２０のいずれかに記載の制御方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は燃料電池装置に関し、詳しくは、酸素極と燃料極間に挟持される電解質層の水分保持に関する。特に高分子固体電解質膜を有するいわゆるＰＥＭ型の燃料電池装置に好適である。

【０００２】

【従来の技術】燃料電池装置の電池本体は、燃料極（水素を燃料極とする場合は水素極とも言う）と空気極（酸素が反応ガスであるので酸素極とも言う。また酸化極ともいう）との間に電解質が挟持された構成である。

【０００３】ところで、上記電解質は、プロトンを伝導させるので、水分を含んでいる必要がある、ところが、燃料電池の温度が高温になると、電解質中の水分が放出され、電解質の抵抗が大きくなり、運転できなくなってしまう。

【０００４】

【発明が解決しようとする課題】本発明は、簡易な構成で効率よく運転できる燃料電池装置及びその運転方法（制御方法）を提供するものである。

【０００５】

【課題を解決するための手段】この発明は上記課題に鑑みてなされたものであり、その構成は次の通りである。即ち、電解質と該電解質を挟持するように配設された燃料極及び空気極とを備えた燃料電池本体と、前記空気極表面に液体を供給する液体供給手段と、前記空気極表面に送風する送風量を調節する送風量調節装置と、前記燃料電池本体の運転状況を検出する運転状況検出手段と、検出された運転状況に応じて、前記液体供給手段による液体の供給をオンオフ制御で行うとともに、前記送風量調節装置による風量の調節をオン状態で風量の増減で行う制御装置を備えたことを特徴とする燃料電池装置。

【０００６】このように構成された燃料電池装置によれば、プロセス空気の供給量が可変となるので、プロセス空気の供給量を変化させてこれを最適量とすることにより、空気極に供給された水の潜熱を利用する冷却が十分かつ効率良く行われる。これにより、空気極ひいては燃料電池本体が効率よく冷却されることとなる。なお、水の潜熱を効率良く利用する手段として、水の粒径は５０μｍ～５００μｍとすることが好ましい。燃料電池本体の電解質膜の厚さは２００μｍ以下であることが望ましい。即ち、燃料電池本体の温度が高温で運転されてこれの温度を下げたいときには、充分量の水が供給されている下で空気の供給量（送風量、単位時間当たりに供給される空気量、単位時間当たりに空気室Ａ（図３参照）を通過する空気量）を大きくする。空気供給量が固定のタイプでは、水の顕熱を利用するため多量の水を供給する必要上種々の不具合があったが、空気供給量を多くしても不具合はほとんど生じない。空気供給量を多くしたとしても空気供給装置（ファンなど）にかかる負荷は水量増大の場合にかかる負荷に比べて無視できるほど小さいからである。燃料電池本体が低温で運転されてこれの温度を上げたいときには、空気供給量が過剰とならないように風量を落とす。これにより、燃料電池本体の温度を確実に上げることができると共に、空気供給装置で消費される電力を可及的に小さくし、もって動力損の低減を図る。また、水リサイクル用の凝縮器についても、内部温度が上がり外気との温度差が大きくなるので、その容量を小さくできる。更にこの発明によれば、液体である水の供給が燃料電池本体の運転温度などの運転状況に応じてオンオフ制御される。水の供給にオフの時間を設けることにより、水の過剰供給を防止できるともに液体供給装置の消費電力を可及的に低減できる。オン・オフで制御されるため、オン時に多量の水を噴射してもオフの時間を調整することで単位時間当たりの平均吸水量を一定に制御できる。オン時に多量の水を噴射させることにより空気極の全面に対して水を均一にかつ確実に供給できることとなる。このように、空気の送風量及び／又は液体の供給量を制御することにより燃料電池本体の運転状況（運転温度）を所定の範囲内に収めることが可能となる。水の代わりに又は水と併用してアルコールなどの液体を用いることが出来る。

【０００７】この発明によれば、空気の供給量と水の供給量とが独立しているので、それらが独立していない供給系に比べて、空気と水のそれぞれを必要なタイミングで必要な供給量を独立して制御することができる。そのことによって、無駄がなく効率的に高い燃料電池の出力が得られる。また、回収する空気、水の量も最小限にすることができるので、凝縮器も小さくすることができ、補器による消費電力の節約にもなる。また、起動にかかる時間も短縮できる。

【０００８】図１は各ストイキ比における燃料電池本体の負荷（電流密度）と温度（空気排気温度）との理論上の関係を示す。ここに、ストイキ比とは、燃料電池反応で消費される理論上の酸素量を含むプロセス空気量を基準として空気極に供給される空気量を規定したものである。従って、ストイキ比が１の場合は、理論上必要な最

小限の空気量が送られる場合であり、ストイキ比が２になると空気供給量はストイキ比１のときの２倍となる。図１より、ストイキ比が小さいほど、即ち空気供給量が少ないほど同じ負荷を得るのに高い温度で燃料電池本体を運転できることがわかる。燃料電池本体の運転温度はこれが高ければ高いほど効率が高くなる。またその高温運転により排出空気の温度も上がるので凝縮器の容量を小さくすることもできる。従って、要求される負荷を賄える最も高い温度で燃料電池本体を運転することが好ましい。負荷と燃料電池本体の温度とはストイキ比により一義的に決められるので、負荷と温度の一方を検出してストイキ比、即ち空気供給量（厳密には空気室入口に供給される量）を決めればよいことになる。

【０００９】しかしながら現状の燃料電池では燃料電池本体の運転温度とストイキ比（空気供給量）とに各種の制限がある。例えば、燃料電池本体の焼きつきを確実に防止するため、その運転温度は、例えば１００～８０℃以下とする必要がある。また、本発明者らの検討によれば、図１に示す破線Ｌより上側の条件での運転は不可能であった。これは、空気供給量が少ないときには（風量が小さいときには）、空気供給路やガス拡散層の抵抗、触媒の能力等のため空気が空気極に充分届かないなどの理由によるものと推定される。従って、図１において、例えば８０℃以下でかつ破線Ｌより下側の領域（所定の範囲内）で燃料電池本体は運転可能である。そして、その効率を考慮すれば、当該運転可能領域の最高温度縁でこれを運転することが好ましい。

【００１０】負荷変動の激しい車輌用の燃料電池装置では、要求される負荷に応じて空気供給量を変化させる。そのとき同時に燃料電池本体の温度を検出して、要求された負荷を実現できる最高温度、即ち最小のストイキ比（空気供給量）となるように空気供給量を調整することが好ましい。一方、殆ど負荷が変動しない環境で使用される燃料電池装置においては、実質的に燃料電池本体の温度のみを監視して、その温度が変動したときのみこれが所望の温度となるように空気供給量を調節すればよい。即ち、燃料電池本体の温度が所望の温度範囲より低くなった場合には空気供給量を低減させて水の潜熱を利用した冷却効果を下げ、他方燃料電池本体の温度が所望の温度範囲より高くなった場合には空気供給量を増大して水の潜熱を利用した冷却効果を上げる。外部の環境や補機の性能により燃料電池装置の運転条件には様々な制限が課せられる。場合によっては、燃料電池本体の運転条件が図１における運転可能条件領域において四角で示した領域に限られることがある。この領域では、燃料電池本体の運転温度はストイキ比１のラインを超えることはない（燃料電池本体を常に稼動させておくため常に少なくともストイキ比１に対応した空気量が供給されているものとする。）。従って、燃料電池本体の温度を監視する必要はない。よって、負荷のみを監視して当該負荷を出力可能な最低量の空気が供給されるようにする。

【００１１】上記いずれの場合においても、空気極には常に充分な量の水が供給されているものとする。即ち、燃料電池本体の熱により蒸発するものがあっても、空気極及びその周囲（即ち空気室内）には、燃料電池装置の運転中は常に液体状の水が存在しているものとする。このように空気極に水が常に存在するので水の潜熱を効率良く利用できることとなる結果、燃料電池本体のスタックから冷却板を間引いたりこれを省略することができる。充分な量の水の蒸発が確保できないおそれのある場合を考慮して、冷却板若しくは冷却パイプその他の冷却装置を燃料電池本体のスタックに備えておくことが好ましい。かかる冷却装置へ流通する熱媒体（通常は水）によりスタックの熱を外部に取り出し、車内の暖房などに利用することができる（いわゆるコジェネとしての利用）。

【００１２】上記において、プロセス空気は実質的に圧縮されずに空気極に供給されるものである。なお、この発明は加圧された酸化ガス供給系を備えるタイプの燃料電池装置に適用することもできる。酸化ガス供給系に酸化ガスの圧縮機が備えられる場合はもとより、ガス配管の管路抵抗によって系内が大気圧より高い圧力となる場合も当該加圧された酸化ガス供給系に含まれる。燃料電池本体の温度は当該燃料電池本体に温度計を付設してこれを測定できることは勿論であるが、図１に示すように、排気空気の温度を測定することによりその温度を間接的に測定することも可能である。この場合、燃料電池本体から排出された直後の空気の温度を測定することが好ましい。これらの温度に基づき燃料電池本体の運転状況を検出する。温度計が運転状況検出手段となる。燃料電池本体の負荷は、燃料電池本体の両極間の電流と電圧の積である。プロセス空気の供給量を制御するときに参考とするパラメータとしては、燃料電池本体が現実に出力している現在の負荷を検出し、これを用いることができる。その他、燃料電池本体に次に要求される負荷、例えば速度、トルク若しくはアクセルの開度を検出し、これを当該パラメータとして用いることもできる。

【００１３】

【実施例】次ぎに、この発明の実施例について説明をする。図２は実施例の燃料電池装置１の概略構成を示す。図３は燃料電池本体１０の基本ユニットを示す。図２に示すように、この装置１は燃料電池本体１０、燃料ガスとしての水素ガス供給系２０、空気供給系３０、水供給系４０から概略構成される。

【００１４】燃料電池本体１０の単位ユニットは空気極１１と燃料極１３とで固体高分子電解質膜１２を挟持した構成である。実際の装置ではこの単位ユニットが複数枚積層されている（燃料電池スタック）。空気極１１の上方及び下方にはそれぞれ空気を吸入、排気するための空気マニホールド１４、１５が形成されている。上方の

マニホールド１４にはノズル４１を取り付けるための取付孔が形成されている。ノズル４１から噴出される水の噴出角度には制限があり、かつ水を霧状にしてこれを空気極１１の全面に行き渡らせるには、ノズルと空気極１１との間に所定の間隔が必要になる。従って、このマニホールド１４は比較的背の高いものとなる。一方、下側の空気マニホールド１５は滴下した水を効率よく排出できるものとする。なお、ノズルはマニホールド１４の側面に設けることもできる。かかるノズルより噴出される水はマニホールド１４内の全域に行き渡り、よって空気極１１の全面に行き渡ることとなる。ノズルをマニホールド１４の側面に設けることにより、低いマニホールドが採用できる。よって燃料電池本体の小型化を図ることができる。

【００１５】ノズルは空気極表面へ向けて直接水を噴射することが好ましい。これにより空気供給量の如何に拘わらず、所望の量の水を空気極表面に供給することが出来る。即ち、空気の供給量と水の供給量とを独立して制御可能となる（独立供給タイプ）。かかる独立供給タイプによれば、起動時など大きな空気供給量（風量）の状態においても所望量の水を確実に空気極表面に供給できる。よって、起動時間の短縮が図れる。空気流中に水滴を放出して、これを空気流にのせて空気極へ供給するタイプでは空気供給量と水供給量とを独立して制御できない（非独立供給タイプ）。空気供給量の変更と水供給量の変更とは常に同時に要求されるわけではなく、独立してそれらの変更が必要となる場合がある。例えば、空気の供給量のみの変更が必要な場合に水の供給量までもが変更されてしまうと、燃料電池本体の制御のレスポンスが遅くなり、ひいては燃料電池装置の出力低下を招くおそれがある。これに対し、本発明の採用する独立供給タイプでは、必要なタイミングで必要な量の水及び／又は空気を供給できるので、燃料電池本体を効率良く制御できる。また、水と空気の供給を独立して制御することにより、無駄な空気及び無駄な水の供給を避けられる。この点においても、燃料電池本体の稼動が効率的なる。更には、無駄な水や無駄な空気の供給を避けることにより、凝縮器の容量も小さくすることが出来る。

【００１６】図３に示すように、上記空気極１１－固体高分子電解質膜１２－燃料極１３の単位ユニットは薄い膜状であり、一対のカーボン製コネクタ板１６、１７により挟持されている。空気極１１に対向するコネクタ板１６の面には空気を流通させるための溝１８が複数条形成されている。各溝１８は上下方向に形成されてマニホールド１４、１５を連通している。その結果、ノズル４１より供給される霧状の水は当該溝１８に沿って空気極１１の下側部分まで達する。この溝１８の周面及び空気極１１の表出面により空気室Ａが構成される。空気室Ａの図示上側開口部が送風の入口（上流側開口部）であり、図示下側の開口部が送風の出口（下流側開口部）である。この出口の排気温度を検出するように温度計を設けることが好ましい。実施例では水などの液体を上流側開口部に対して直接噴出させて供給する構成であるが、水などの液体は下流側開口部から供給することも可能である。更には、コネクタ板に図示左右方向の貫通孔を形成し、ここから空気室Ａへ水などの液体を供給することも出来る。このようにして供給された水は空気室Ａを構成する面（溝１８の周面及び空気極１１の表出面：これらは比較的高温になり易い）において専ら蒸発する。同様に、燃料極１３に対向するコネクタ板１７の面には水素ガスを流通させるための溝１９が形成されている。実施例ではこの溝１９を水平方向に複数条形成した。この溝１９の周面とコネクタ板１７の表出面とで燃料室Ｂが形成される。この燃料室Ｂに対して、既述の空気室Ａと同様にな方法で水を供給することも出来る。

【００１７】空気極１１には水が供給されるのでこれは耐水性のある材料で形成される。また、そこに水の膜ができると空気極１１の実効面積が減少するので空気極１１の材料には高い撥水性も要求される。かかる材料として、カーボンクロスを基材として（Ｃ＋ＰＴＦＥ）をぬりこんだガス拡散層を使用した。固体高分子電解質膜１２には汎用的なナフィオン（商品名：デュポン社）の薄膜を使用した。尚、膜の厚さは空気極側からの生成水の逆浸透が可能であればよく、例えば２０～２００μｍとする。燃料極１３は空気極１１と同じ構造で形成されている。燃料極１３と空気極１１とで構造を変化させてもよい。

【００１８】空気極１１、及び燃料極１３において電解質膜１２と接触する方の面には、ある程度の厚さでもって酸素と水素の反応を促進するために用いられる周知の白金系触媒がそれぞれ均一に分散されていて、空気極１１及び燃料極１３における触媒層として形成される。

【００１９】水素ガス供給系２０の水素供給装置２１として、この実施例では水素吸蔵合金からなる水素ボンベを利用した。その他、液体水素の水素ボンベ、水／メタノール混合液等の改質原料を改質器にて改質反応させて水素リッチな改質ガスを生成させ、この改質ガスをタンクに貯留しておいてこれを水素源とすることもできる。燃料電池装置１を室内で固定して使用する場合には、水素配管を水素源とすることができる。水素供給装置２１と燃料極１３とは水素供給調圧弁２３を介して水素ガス供給路２２により接続されている。調圧弁２３は燃料極１３に供給する水素ガスの流量を調整するものであり、汎用的な構成のものを利用できる。

【００２０】燃料極１３からの排気ガスは外気へ排出される。なお、この排気ガスを空気マニホールドへ供給し、ここで空気と混合することもできる。

【００２１】空気極１１にはファン３８によって大気中より空気が供給される。図の符号３１は空気の供給路であり空気極１１のマニホールド１４に連結されている。

下側のマニホールド１５には空気極１１を通過した空気を循環若しくは排気するための空気路３２が連結され、水を分離する凝縮器３３を介して排気ガスは排気路３６へ送られる。空気排気調圧弁３４の開度により排気路３６から排気される量が調節される。また、排気調圧弁３４を省略し、排気ガスをそのまま大気へ排出する構成とすることもできる。かかる空気供給系３０においては、空気圧縮機は特に備えられておらず、系全体に渡って実質的に大気圧が維持される。符号３９は排出された空気の温度を検出するための温度計である。

【００２２】凝縮器３３で分離された水はタンク４２へ送られる。タンク４２には水位センサ４３が付設される。この水位センサ４３により、タンク４２の水位が所定の値以下となると、アラーム４４が点滅してオペレータに水不足を知らせる。それとともに、凝縮器３３の能力を変化させて水の回収量を調整することが好ましい。即ち、水が不足しているときは凝縮器３３のファンの回転数を高めて水をより多く回収し、他方水が過剰になると凝縮器３３のファンの回転数を低下若しくは停止して水の回収量を少なくする。

【００２３】実施例の水供給系４０では、タンク４２から水供給路４５がポンプ４６、水圧センサ４７及び調圧弁４８を介して、ノズル４１まで連結されている。調圧弁４８により所望の水圧に調節され、もって水量の調節された水はノズル４１から吹き出して空気マニホールド１４内では霧状になる。そして、吹き出し時の運動量（初速）、霧の自重および空気流等によって空気極１１の実質的な全面に霧状の水が供給される。水量及び水の供給は、調圧弁とノズルとの組み合わせに限定されるものではない。

【００２４】このようにして空気極１１の表面に供給された水はそこで周囲の空気、電極表面、さらにはセパレータ表面から潜熱を奪って蒸発する。これにより、電解質膜１２の水分の蒸発が防止される。また、空気極１１へ供給された水は空気極１１からも潜熱を奪うので、これを冷却する作用もある。特に、始動時に水を供給したとき、水素と空気の燃焼により膜、触媒がダメージを受けることを予防できる。

【００２５】図中の符号５０は電流計であり、空気極１１と燃料極１３との間の電流を計測する。電流計５０により計測された電流より図１の電流密度が求められる。この実施例では抵抗５１が一定のため、両極１１、１３間の電流を測定することにより燃料電池本体１０に掛かっている負荷（＝仕事）が求められる。燃料電池装置を車輌用に使用するときには両極間の電流と電圧を共に測定し、もって燃料電池本体に掛かっている負荷（燃料電池本体が現在出力してるパワー）を得ることが好ましい。車輌用の場合には、速度、トルク若しくはアクセルの開度から燃料電池本体に要求されるパワーを予測してその値を用いることもできる。

【００２６】次ぎに、実施例の燃料電池装置１の動作を説明する。図４は燃料電池装置１の動作を制御するときに関与する要素を示したブロック図である。図５は燃料電池装置１の制御を示すメインフローである。図４において、制御装置７０及びメモリ７３は燃料電池装置１のコントロールボックス（図１に示されていない）に収納されている。メモリ７３にはコンピュータからなる制御装置７０の動作を規定するコントロールプログラム及び各種制御を実行するときのパラメータやルックアップテーブルが収納されている。

【００２７】まず、図５のステップ１で実行される水素ガス供給系２０の動作について説明する。起動時には、水素排気弁２５を閉に保持しておいて、爆発限界以下の所定の濃度で水素ガスが燃料極１３に供給されるように水素供給調圧弁２３を調整する。排気弁２５を閉じた状態で燃料電池装置１を運転すると、空気極より透過する$N_2$、$O_2$あるいは生成水の影響で燃料極１３で消費される水素の分圧が徐々に低下するためこれに伴って出力電圧も低下し、安定した電圧が得られなくなる。

【００２８】そこで、予め定められた規則に基づいて弁２５を解放して水素分圧の低下したガスを排気し、燃料極１３の雰囲気ガスをリフレッシュする。予め定められた規則はメモリ７３に保存されており、弁２５の開閉及び調圧弁２３の調整は制御装置７０が当該規則をメモリ７３から読み出して実行する。

【００２９】この実施例では、電流計５０で出力電流をモニタし、出力電流が所定の閾値を超えて低下したら所定の時間（例えば１秒間）弁２５を解放する。あるいは、弁２５を閉とした状態で燃料電池装置１を運転したときに出力電圧が低下し始める時間間隔を予め計測しておき、その時間間隔と実質的に同一又は若干短い周期で弁２５を解放するように、弁２５を間欠的に開閉制御する。

【００３０】次ぎに、図５のステップ３で実行される空気供給系３０の動作について、図６を参照しながら説明する。ステップ３１において燃料電池本体１０から排出された直後の排気空気の温度を温度計３９により検出する。その温度が８０℃を超えていると（ステップ３２）、燃料電池本体１０が焼きつくおそれがあるので、ファン３８の回転数を増して風量を増大し（ステップ３３）、もって熱発生源である空気極１１の温度を下げる。このとき、当然ながら空気極１１には８０℃を超えた燃料電池本体１０を冷却するのに必要な量の水が供給されているものとする。検出された温度が８０℃以下の場合には、燃料電池本体１０の負荷を検出する（ステップ３４）。本実施例の場合は、図１の関係を制御に用いるので、空気極１１と燃料極１３の間の電流を検出する。制御装置７０は電流計５０で検出した電流値から電流密度を演算する。そして、制御装置７０はその電流密度の値とステップ３１で検出した温度とをメモリ７３に

テーブル形式で保存されている図１の関係に照らし合わせる。
【００３１】例えば、検出された温度と電流密度の関係が図１のＡの条件であれば、風量を下げて、燃料電池本体１０の運転状態を図１のＢの条件に移行させる。即ち空気の供給量をストイキ比２に対応する量にまで下げて潜熱による冷却効果を低減させる。これにより、燃料電池本体１０は出力（電流密度）を維持したまま、最も高い温度で運転されることとなる。なお、燃料電池本体１０の温度を効率よく上げるためには、燃料電池本体が酸素不足にならないレベルで当初の風量をストイキ比２に対応するものよりも小さくして昇温速度を速め、条件Ｂの温度（ほぼ８０℃）に近づいてきたところで、風量をストイキ比２に対応するものとすることが好ましい。なお、空気供給量（ストイキ比）と風量（ファン３８の回転数）との関係が予めメモリ１に保存されており、制御装置７０は求める空気供給量に対応した風量が得られるようファン３８の回転数を制御する。ファン３８には例えばサーボモータ駆動タイプが用いられる。
【００３２】条件Ｂで運転されていた燃料電池本体１０の電流密度が０．７に変化したとすると、燃料電池本体１０は条件Ｃで運転する必要がある。この場合は、風量を条件Ｃの風量（ストイキ比５に対応するところ）まで上げて燃料電池本体１０の温度を条件Ｃの温度（ほぼ７０℃）まで下げる。このように燃料電池本体１０の運転温度はその運転可能領域において可能な限り高い温度とすることが好ましい。
【００３３】次ぎに、図５のステップ５で実行される水供給系４０の動作について説明する。タンク４２の水がポンプ４６で圧送される。そして、噴射圧力調整弁４８でその圧力が調整されてノズル４１から噴霧される。これにより、水が液体の状態（霧の状態）で空気極１１に供給されることとなる。勿論、調圧弁４８を省略して、ポンプ４６に印加される電圧を調整しポンプ４６の吐出圧力自体を制御し、もっと所望の水量を得ることもできる。
【００３４】水の供給量は燃料電池本体の温度に応じて予め定められいる。即ち、燃料電池本体をその温度に維持するために必要な最小量の水が供給される。ポンプ４６による動力損をできる限り少なくするためである。なお、燃料電池本体が所定の温度（例えば３０℃）以下になれば、水の供給を止めることもできる。また、他の所定温度（例えば５０℃）以下３０℃を越えるとき、水の供給を間欠的にすることもできる。燃料電池本体１０の温度とそのときに供給すべき水量との関係はメモリ７３に保存されている。この実施例では、図７に示すとおり、まず排出空気の温度が検出される（ステップ５１）。そして、検出された温度に基づき最適水噴射量が演算される（ステップ５３）。この演算はメモリ７３に保存されていた関係を参照して行われる。
【００３５】次ぎに、ステップ５３において最適水噴射量に対応する最適水圧力を演算する。例えば、水噴射量と水圧力とは図８に示す関係があるので、この関係が方程式若しくはルックアップテーブルのかたちでメモリ７３に予め保存されている。この実施例では、ポンプ４６を一定のパワーで運転しておいて循環路４９の調圧弁４８の開度によりノズル４１の水圧力を調節している。即ち、調圧弁４８の開度が大きく（小さく）なればノズル４１の水圧力は小さく（大きく）なる。
【００３６】従って、ステップ５４では水圧センサ４７によりノズル４１にかかる水圧力を検出し、フィードバック制御によりその水圧力が所望の値（最適水圧力）となるように調圧弁４８を調節する（ステップ５５）。
【００３７】その他、所定の時間経過（例えば５～１０秒）ごとに、一定の水圧で水供給系４０を稼働させても良い。
【００３８】次ぎに、実施例の燃料電池装置１の起動時の動作について説明する。図９に示すとおり、スイッチ（図示せず）がオンとなると（ステップ９１）、ポンプ４６をオンとする（ステップ９３）。そして、燃料電池本体１の運転状況（運転温度）に無関係に、所定の水噴射量となるように調圧弁４８が調節されてノズル４１より水が噴射される（ステップ９５）。異常反応から燃料電池本体１０を守るために空気極１１へ噴射される水量は最大量とする。
【００３９】その後、空気供給系３０をオンにする（ステップ９７）。このときファン３８の風量も最大として燃料電池本体１０を冷却し、異常反応の防止を図る。引き続いて水素供給系２０をオンにする（ステップ９９）。空気極１１と燃料極１５との間に所望の出力が確認されたら、電力を外部に出力する。
【００４０】上記において、空気供給系３０の稼動は水供給系４０の稼動前であっても良い。また、水素供給系２０の稼動の後に空気供給系３０を稼動させても良い。ただし、水素供給系２０を稼動させる前に水供給系４０を稼動させる必要がある。空気供給系３０の稼動の有無にかかわらず燃料電池本体１には空気が存在しているので、電解質膜１２が乾燥した状態で水素を供給すると、異常燃焼の発生する可能性がある。つまり、この異常熱が発生したとき、燃料電池本体１がダメージを被らないように、水素を供給する前に水を噴射して予め空気極１１を濡らしておく。こうすることで、異常熱を水の蒸発熱に換え、更には電解質膜１２の湿潤を促進して、燃料電池本体１のダメージを未然に防止する。
【００４１】次に、他の実施例を図１０～１２に基づいて説明する。なお、既述の実施例で説明した要素及びステップには同一の参照番号を付してその説明を省略する。この実施例の燃料電池装置１０１では、ファン３８の下流側にダンパ１３８が設けられる。ファン３８を一定の回転数で駆動させておいてダンパ１３８を調節する

ことにより空気供給量を変化させる。またこの実施例では温度計を燃料電池本体１０に、好ましくは空気極側のコネクタ板に、取り付け、燃料電池本体１０の温度を直接測定する。更にこの実施例では、車輌用のアクセルの開度を検出し、検出した開度より燃料電池本体１０へ次に要求される負荷を制御装置７０が演算する（図１２、ステップ１３４）。なお、このステップ１３４において、図１の関係が利用できるように、制御装置７０は得られた負荷を更に電流密度に変換するものとする。

【００４２】この実施例によれば、燃料電池本体に要求される負荷をアクセルの状態から直接読み取るので、空気供給量をより迅速に制御できる。この実施例の他の作用効果は前の実施例と同じである。

【００４３】この発明は、上記発明の実施の形態及び実施例の説明に何ら限定されるものではない。特許請求の範囲の記載を逸脱せず、当業者が容易に想到できる範囲で種々の変形態様もこの発明に含まれる。

【図面の簡単な説明】

【図１】燃料電池本体の電流密度（負荷）、空気排気温度（本体自体の温度）及びストイキ比（空気供給量）との関係を示すグラフである。

【図２】この発明の位置の実施例の燃料電池装置の構成を示す模式図である。

【図３】同じく燃料電池本体の基本構成を示す断面図である。

【図４】同じく燃料電池装置の制御系を示す模式図である。

【図５】同じく燃料電池装置の動作を示すメインフローである。

【図６】同じく空気供給系の動作を示すフローチャートである。

【図７】同じく水供給系の動作を示すフローチャートである。

【図８】同じく水噴射量と水圧力の関係を示すグラフ図である。

【図９】同じく起動時の制御を示すフローチャートである。

【図１０】この発明の他の実施例の燃料電池装置の構成を示す模式図である。

【図１１】同じく制御系を示す模式図である。

【図１２】同じく空気供給系の動作を示すフローチャートである。

【符号の説明】

１、１０１　燃料電池装置

１０　燃料電池本体

１１　空気極

３０　空気供給系

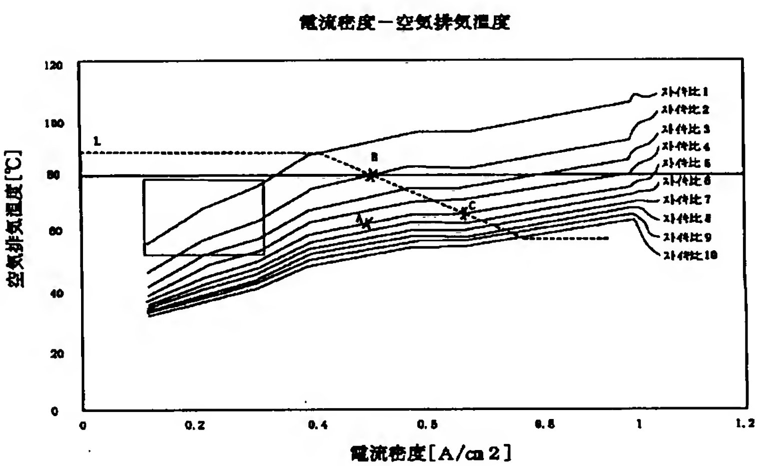
３８　ファン

３９、１３９　温度計

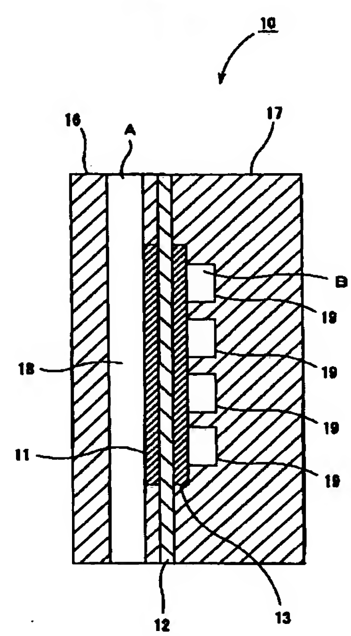
４０　水供給系

５０　アンペアメータ

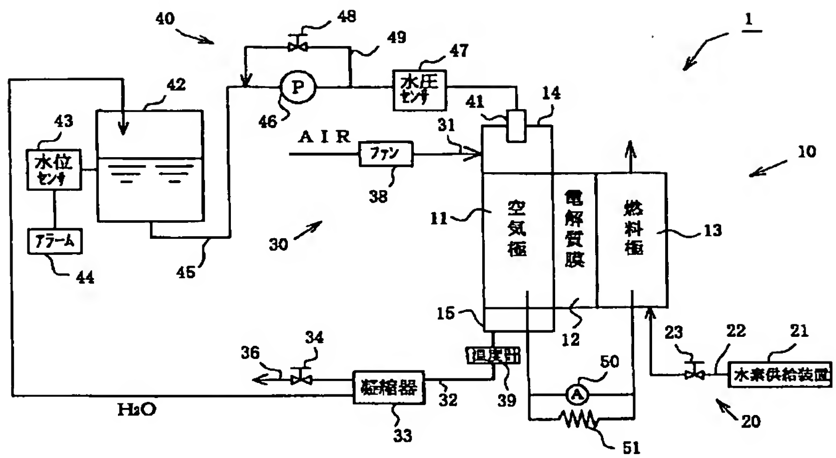
【図１】



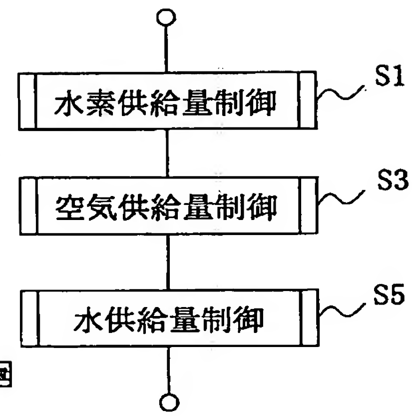

【図３】



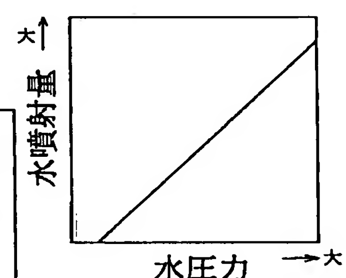
【図２】



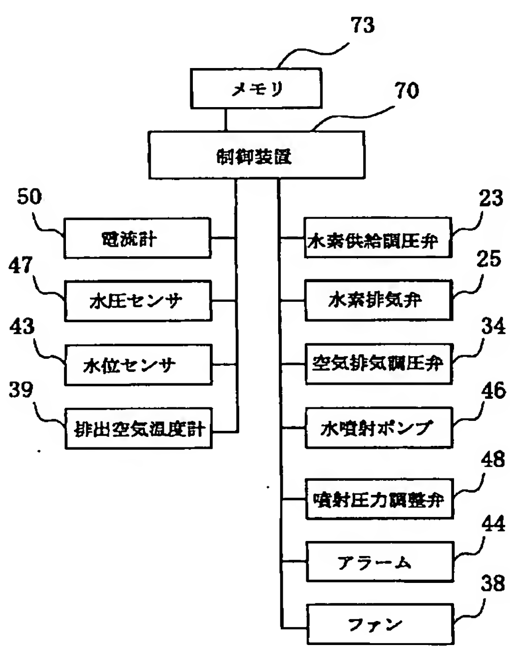

【図５】



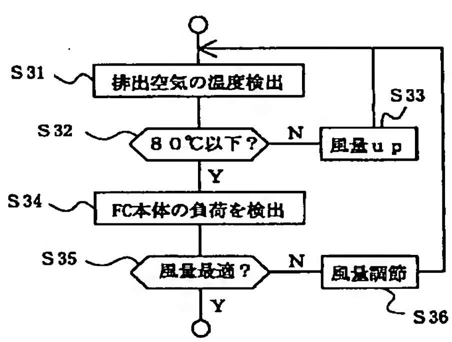

【図８】



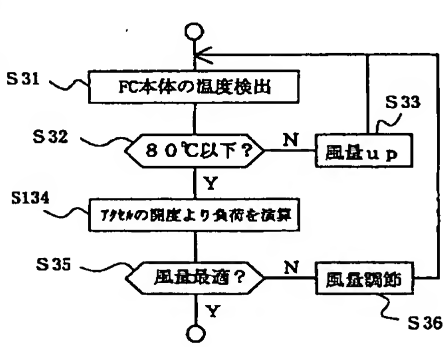

【図４】



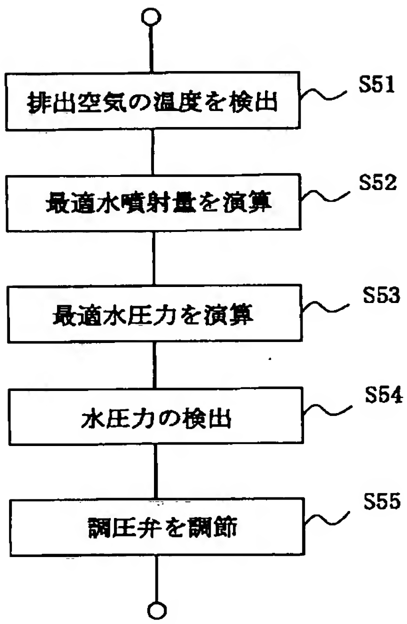

【図６】



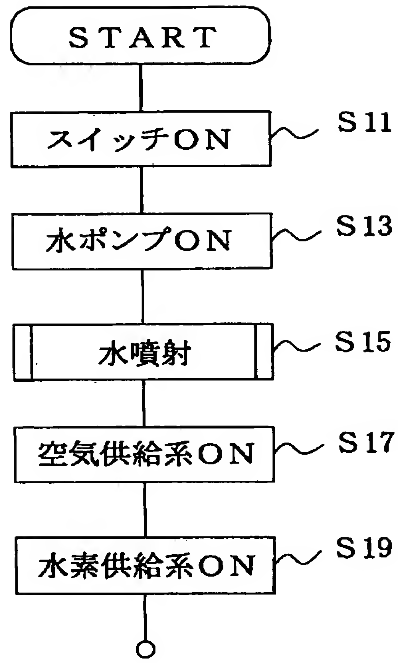

【図１２】



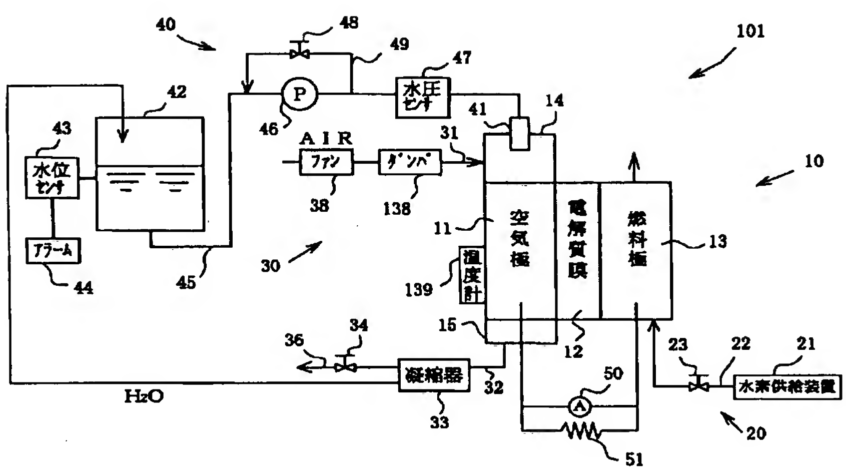
【図７】


排出空気の温度を検出
S51
最適水噴射量を演算
S52
最適水圧力を演算
S53
水圧力の検出
S54
調圧弁を調節
S55

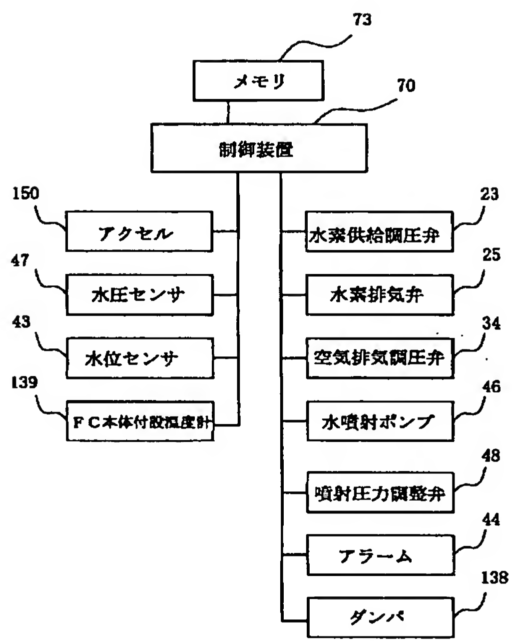
【図９】


START
スイッチON
S11
水ポンプON
S13
水噴射
S15
空気供給系ON
S17
水素供給系ON
S19

【図１０】


40
48
49
47
101
42
水圧センサ
P
41
14
43
46
AIR
31
水位センサ
ファン
ダンパ
10
38
138
11
空気極
電解質膜
燃料極
13
アラーム
45
30
温度計
44
139
15
12
34
23
22
21
36
凝縮器
32
50
水素供給装置
H2O
33
A
20
51

【図１１】


73
メモリ
70
制御装置
150
アクセル
47
水圧センサ
43
水位センサ
139
ＦＣ本体付設温度計
23
水素供給調圧弁
25
水素排気弁
34
空気排気調圧弁
46
水噴射ポンプ
48
噴射圧力調整弁
44
アラーム
138
ダンパ